

SECTION 260000 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.
- B. This section describes specific requirements, products, and methods of execution, which are typical throughout the electrical work of this project. Additional requirements for the specific systems may modify these requirements.
- C. This Section applies to all Divisions 26, 27 and 28 and is part of all other Divisions 26, 27 and 28 Sections.
- D. Index of Electrical Specifications:
 - 1. 260000 - Electrical General Requirements
 - 2. 260519 - Low Voltage Electrical Power Conductors and Cables
 - 3. 260526 - Grounding and Bonding for Electrical Systems
 - 4. 260529 - Hangers and Supports for Electrical Systems
 - 5. 260533 - Raceway and Boxes for Electrical Systems
 - 6. 260553 - Identification for Electrical Systems
 - 7. 260943 - Network Lighting Controls (nLight)
 - 8. 262416 - Panelboards
 - 9. 262726 - Wiring Devices
 - 10. 262800 - Low Voltage Circuit Protective Devices
 - 11. 262816 - Enclosed Switches and Circuit Breakers
 - 12. 262900 - Low Voltage Controllers
 - 13. 262916 - Enclosed Contactors
 - 14. 263213 - Diesel Engine Driven Generator Sets
 - 15. 263623 - Automatic Transfer Switches (ATS)
 - 16. 264300 - Surge Protective Devices

17. 265000 - Lighting Fixtures
18. 270536 - Cable Trays for Electrical Systems
19. 272010 - Telecom Distribution System
20. 28 1333 - Security Management System
21. 282310 - IP Closed Circuit Television System
22. 283100 - Addressable Fire Alarm System

1.2 REFERENCES

- A. Codes: Perform work in strict accordance with applicable national, state and local codes; including, but not limited to the latest legally enacted editions of the following specifically noted requirements:
 1. NFPA 70, National Electrical Code - NEC.
 2. ANSI-C2, National Electrical Safety Code - NESC.
 3. International Building Code - IBC.
 4. International Fire Code - IFC.
 5. Underwriters Laboratory (UL) or approved equal.
- B. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
 1. American National Standards Institute - ANSI.
 2. American Society for Testing and Materials - ASTM.
 3. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
 4. Institute of Electrical and Electronics Engineers - IEEE.
 5. Insulated Cable Engineers Association - ICEA.
 6. National Electrical Manufacturers' Association - NEMA.
 7. National Fire Protection Association - NFPA.

1.3 DEFINITIONS

- A. "Accessible" means arranged so that an appropriately dressed man, 6 feet-2 inches tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended and may then position himself to properly and safely perform the task to be accomplished, without disassembly or damage to the surrounding installation.
- B. "Authority Having Jurisdiction" is the individual official, board, department, or agency established and authorized by the political subdivision created by law to administer and enforce the provisions of the Code as adopted or amended.
- C. "As Specified" denotes a product, system, or installation that:
 - 1. Includes all of the salient characteristics identified in the Drawings and Specifications;
 - 2. Meets all of the requirements of the "Basis of Design"; and
 - 3. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.
- D. "Basis of Design" refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as switchboards that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving all impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and all Codes.
- E. "Contracting Agency" is the Owner as defined in the General Conditions of the Contract.
- F. "Demolish" means to permanently remove a component, equipment, or system and its appurtenances with no intent for reuse and to properly dispose of it.
- G. "Furnish" means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere as noted or agreed to be installed by supporting crafts.
- H. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
- I. "Product" is a generic term that includes materials, equipment, fixtures and any physical item used on the project.
- J. "Provide" means furnish all products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.
- K. "Remove" means to remove a component, equipment, or system and its appurtenances and either store it for re-installation, reuse, or turn it over to the Contracting Agency.
- L. "Rough-in and Connect" means provide an appropriate system connection such as conduit with junction boxes, wiring, switches, disconnects, etc., and wiring connections. Equipment

furnished is received, uncrated, assembled, and set in place under the Division in which it is specified.

- M. "Serviceable" means arranged so that the component or product in question may be properly removed, and replaced without disassembly, destruction or damage to the surrounding installation. "Serviceable" components shall be "accessible".
- N. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and complete coordination of all trades.
- O. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Contract Documents, but which the Contractor warrants meets all specific requirements listed in the Contract Documents.
- P. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Suppression Drawings may be both System Drawings and Shop Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide labor, products and services required for the complete installation, checkout and startup of electrical systems shown and specified. Where the work of several crafts is involved, coordinate related work to provide each system in complete and in proper operating order.
- B. Lay out the work in advance and avoid conflict with other work in progress. Physical dimensions shall be determined from existing conditions. Verify locations for junction boxes; disconnect switches, stub-ups, etc., for connection to equipment furnished by others, or in other Divisions of this Work.
- C. Refer to the "Suggested Coordination Schedule" in Section 200000 - Mechanical General Requirements.
- D. Cooperate with others involved in the project, with due regard to their work, to promote rapid completion of the entire project.
- E. Coordinate installation of panels, equipment, system components, and other products to provide proper service areas and access for items requiring periodic maintenance inspection or replacement.
- F. Reference to a specific manufacturer's product (even as "Basis of Design") does not necessarily establish acceptability of that product without regard to compliance with all other provisions of these specifications.
- G. Local Conditions: The Contractor shall thoroughly familiarize himself with the work as well as the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions and other local conditions which may affect the progress and quality of the work.

- H. Utility Coordination: Coordinate work with the serving utilities (electrical, telephone, cable television, etc.) and provide equipment and installation in accordance with the respective utility requirements. Meet with the serving utilities and coordinate the installation and location of the services. Provide a written statement of approval from each serving utility. Provide trenching from telephone and television stubout locations to property line in accordance with respective utility requirements.
- I. Provide commissioning services as specified in Division 1

1.5 SUBMITTALS

- A. Refer to Division 1 for general submittal, closeout submittal and product substitution requirements. In addition, prepare Divisions 26, 27 and 28 submittals in accordance with the following.
- B. Specification section drawings, calculations, and products shall be complete and submitted together in one package.
- C. General:
 - 1. The Contracting Agency's obligation to review submittals and to return them in a timely manner is conditioned upon the prior review and approval of the submittals by the Contractor as required by the Construction Contract.
 - 2. Streamlining: in many instances, the products, reference standards, and other itemized specifications have been listed without verbiage. In these cases, it is implied that the Contractor shall provide the products and perform in accordance with the references listed.
 - 3. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.
 - 4. Submittals will not be checked for quantity.
 - 5. Submittals will not be exhaustively checked for dimension or fit, or for proper technical design of manufactured equipment. Provision of a complete and satisfactory working installation is the responsibility of the Contractor.
 - 6. Furnish suppliers with the applicable portions of the Contract Documents and review and verify that the suppliers' submittals clearly represent products which comply with the Contract Documents.
- D. Electronic Submittals:
 - 1. Submittals may be in electronic (PDF) format.
 - a. Electronic submittals shall follow the organization and formatting required for paper submittals.
 - 1). Provide electronic bookmarks within the PDF document in place of tabs and sub-tabs.

2). If individual PDF files are provided for each product or shop drawing sheet, organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.

- b. If submittal is a scanned document, run the optical character recognition OCR function to ensure the document is searchable and can be copied and pasted.
- c. Electronic submittals may be transmitted via Email, disc or download from a project or construction Website.

E. Coordination:

1. Create and maintain a master submittal log for all items submitted in Divisions 26, 27 and 28.
2. Prior to submission for approval hold a meeting of all trades to review all shop drawings and submittals. All trades shall cross-check all shop drawings and submittals for conflicts, clearances, physical space allocation and routing, discrepancies, dimensional errors, omissions, contradictions, departures from the Contract requirements.
3. Revise, correct, and appropriately annotate submittals prior to submission for approval.
4. A current copy of approved submittals and the submittal log shall be kept at the job site.

F. Product Submittals

1. General: This section describes in detail the preparation of electrical product submittals. Submittals not provided as described shall be rejected without review. This procedure is designed to accelerate and improve the accuracy of the technical review process, as well as, simplify the preparation of the Installation, Operation, and Maintenance Manuals (IO&Ms) during project closeout.
2. Submittal Organization:
 - a. Organize product submittal information in the same order as the products are specified to simplify the technical review process. Provide a separate tabbed divider for each Divisions 26, 27 and 28 specification section. Provide the typed section number on each tab.
 - b. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable specification section. Provide sub-tabs within each section for each separate product article. Provide the typed product article number on each tab.
 - c. If a particular specified product is being omitted from the product submittal or will not be used for the project, provide a single sheet within the article tab identifying the product and annotated with a brief reason why the product is not being submitted, for example: "NOT USED," NO SUBMITTAL REQUIRED," "TO BE SUBMITTED BY (PROVIDE DATE)," etc. This will inform the reviewer that the product was not overlooked.
 - d. Partial submittals from individual subcontractors may be provided which cover a particular sub-contractor's scope of work. In this case, arrange partial submittals by system classification such as: LIGHTING, POWER DISTRIBUTION, FIRE ALARM, ACCESS CONTROL SYSTEM, etc. Within each system classification,

arrange product submittals by specification section, as described, such that each specification section can easily be reorganized into a master set of Divisions 26, 27 and 28 product submittals organized by specification section. This will greatly simplify the preparation of IO&M manuals as described below.

- e. Provide a master table of contents at the front of each volume which lists the Divisions 26, 27 and 28 specification sections and indicates which sections are located within each volume.
 - f. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
 - g. Provide identical cover for each product submittal volume.
 - h. For multiple volumes, label each volume. Include the following typed information on the front cover of each volume:
 - 1). The Contracting Agency Name
 - 2). Project Name
 - 3). Contractor Name
 - 4). Subcontractor Name preparing the submittal.
 - 5). Date that the submittal or resubmittal was initiated.
 - 6). "Electrical Product Submittals", etc. as appropriate.
 - 7). "Volume 1 of X, Volume 2 of X," etc.
3. Product Information:
- a. Indicate manufacturer's name and address, and local supplier's name, address, phone number.
 - b. Indicate each product as "Basis of Design", "As Specified" or as "Proposed Substitution."
 - c. Identify Catalog designation and/or model number.
 - d. Neatly annotate each salient characteristic and design options of the product to demonstrate compliance with the Contract Documents to include: Scheduled information, drawing information and specified information. Clearly indicate product deviations from the Contract Documents and mark out non-applicable items on generic "cut-sheets."
 - e. Include manufacturer provided dimensioned equipment drawings with mechanical and electrical rough-in connections.
 - f. Include operation characteristics, performance curves and rated capacities.
 - g. Include motor characteristics and wiring diagrams for the specific system.
 - h. Provide basic manufacturer's installation instructions.
4. Provide coordination data to check protective devices.
5. Provide information required to verify compliance with the short circuit withstand and interrupting ratings, as shown on the Drawings or further stated in these Specifications.
6. Provide certification that all data shown on the Drawings or further stated in these Specifications concerning available short-circuit currents has been confirmed with the serving Electric Utility.
7. Product Substitutions:

- a. Clearly indicate both in the section table of contents and on the individual product submittal information each proposed substitution, deviation or change from the product as described in the Contract Documents.
- b. Submittal approval does not include substitutions, deviations or changes from the requirements of the Contract Documents unless they are specifically itemized and approved. The term "No Exceptions Taken" will not apply to substitutions, deviations or changes not clearly identified.
- c. Provision of a satisfactory working installation of equal quality to the system as described in the Contract Documents shall be the responsibility of the Contractor.
- d. Correct unapproved deviations from the Contract Documents discovered in the field as directed by the Contracting Agency at no additional cost to the Owner.

G. System Drawings:

1. Submit System Drawings for dynamic elements/systems of the project which are performance specified to include but not limited to: Fire Alarm Systems, Lightning Protection Systems and stand-alone packaged equipment.
2. Prepare system drawings on full sized sheets of the same size as the original construction drawings.
3. Include with each system a sequence of operation narrative which describes each mode of system operation in sufficient detail to demonstrate compliance with the Contract Documents to the satisfaction of the Contracting Agency.

H. Shop Drawings:

1. General:
 - a. The Contract Documents are not intended for nor are they suitable for use as shop drawings. Do not use Contract Drawings for direct fabrication or installation of products or equipment.
 - b. Divisions 26, 27 and 28 products and systems shall not be installed without shop drawings approved by the Contracting Agency.
 - c. Rework, changes or additional engineering support required as a result of the installation of products and systems prior to the approval of applicable shop drawings by the Contracting Agency shall be provided at the Contractor's expense.
2. Preparation:
 - a. Review each Divisions 26, 27 and 28 specification section and identify the project's shop drawing requirements.
 - b. Prepare shop drawings on full sized sheets of the same size as the original construction drawings.
 - c. Arrange shop drawings to scale, showing dimensions where accuracy of location is necessary for coordination or communication purposes.
 - d. Incorporate the actual dimensions and configurations of the products and systems approved through the product submittal process into the shop drawings.
 - e. Provide dimensioned maintenance clearance areas around each product as recommended by the manufacturer.

- f. Meet with and coordinate Divisions 26, 27 and 28 work with the interrelated work of other trades including Architectural, Civil, Structural, and Mechanical to identify and resolve potential conflicts.
 - g. Clearly identify and provide recommendations to resolve major conflicts which may impact the design of the systems as shown. Resolve such conflicts during the shop drawing review process.
- 3. Shop Drawing Submittal:
 - a. Installation conflicts arising from the failure to properly coordinate the work of related trades shall be resolved at the Contractor's expense.

I. Record Drawings

- 1. General: As the Work progresses, neatly annotate a designated and otherwise unused, set of Divisions 26, 27 and 28 Contract Drawings to show the actual locations and routing of Divisions 26, 27 and 28 Work and the terminal connection points to related Work. As a minimum, include the following:
 - a. Annotate record drawings to incorporate each applicable addendum.
 - b. Annotate record drawings as directed by each applicable Request for Information (RFI) and accepted Change Order Proposal.
 - c. Modify record drawings to show actual equipment sizes and locations.
 - d. Provide fully dimensioned locations for permanently concealed conduits (i.e. conduit cast in concrete or buried underground/underslab).
 - e. Maintain drawings in an up-to-date fashion in conjunction with the actual progress of installation. Accurate progress mark-ups shall be available on-site for examination by the Contracting Agency or his representative at all times.
- 2. Preparation:
 - a. Neatly annotate record drawings to provide clear interpretation to support electronic drafting by a third party.
 - b. Tape electronic sketches from addendums and/or RFIs directly to the record drawings as overlays.
 - c. Annotate the record drawings in colored pencil using the same symbols and abbreviations as indicated in the Divisions 26, 27 and 28 legends and schedules of the Contract Drawings.
 - 1). Red to add information.
 - 2). Green to delete information.
 - 3). Blue to provide additional clarifying information which is not to be drafted.
 - d. After submittal to the Contracting Agency, provide additional clarification, information or rework as necessary to support the accurate interpretation and electronic drafting of the record drawings.
- 3. Submittals:
 - a. Provide dimensioned underslab record drawings to the Contracting Agency.
 - b. Provide complete record drawings for concealed areas (i.e. above lay-in and hard ceilings and inside walls) to the Contracting Agency.

- c. Provide the remaining portion of the record drawings for exposed areas to the Contracting Agency prior to the final completion of the project.
- d. Prepare wiring diagrams for individual special systems as installed. Identify components and show wire and terminal numbers and connections. Include diagrams from the shop drawings and submittals, updated to show as-built condition.

J. Test Certificates:

- 1. Review the submittal requirements for Quality Assurance/Control Submittals for each specification section.
- 2. Submit copies of design data, test reports, certificates, manufacturer's instructions and field test reports as specified. This information may be included within the Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

K. Operations and Maintenance (IO&M) Manuals:

- 1. Provide specific product IO&M information for each section as detailed within each Divisions 26, 27 and 28 section.
- 2. Begin the preparation of the electrical Operation and Maintenance Manuals with a complete and fully approved set of electrical product submittals organized, annotated and with the product information as indicated within the "Product Submittals" article for each specification section.
- 3. Next, augment each individual product submittal with the written installation, operations and maintenance information for each specific product. Obviously, this type of information is not applicable (or available) for bulk commodity or simplistic products such as conduit or equipment tags, etc.
- 4. Maintenance information shall include:
 - a. Preventive maintenance requirements for each product, including the recommended frequency of performance of each preventive maintenance task.
 - b. Instructions for troubleshooting, minor repair and adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and that require no extensive special training or skills.
 - c. Information of a maintenance nature covering warranty items, etc., that have not been discussed in the manufacturers' literature.
 - d. Information data for spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
 - e. Recommended spare parts list.
- 5. Organize the Operation and Maintenance Manual information by specification section (not by sub-contractor).
- 6. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable section.

7. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
8. Provide identical cover for each IO&M manual volume.
9. For multiple volumes, label each volume.
10. Include the following typed information on the front cover of each volume:
 - a. The Contracting Agency Name.
 - b. Project Name.
 - c. "Electrical Operations and Maintenance Manual".
 - d. "Volume 1 of X, Volume 2 of X," etc.

1.6 QUALITY ASSURANCE

- A. Qualifications: Perform the Work using qualified workmen that are experienced and usually employed in the trade.
- B. Product Testing and Certification:
 1. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors shall be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.
 2. Further details on the specific NRTLs, as well as the product standards that they are specifically recognized to evaluate equipment in accordance with, can be found on the OSHA Web site: <http://www.osha.gov/dts/otpcanrtl/>
- C. Drawings and Specifications:
 1. The Drawings and specifications are complementary. Do not scale the Drawings. Locations of devices, fixtures, and equipment are approximate unless dimensioned.
 2. The Drawings are partly diagrammatic and do not show precise routing of conduits or exact location of all products, and may not show in minute detail all features of the installation; however, provide all systems complete and in proper operating order.
 3. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or called for on the Drawings or in the specifications.
- D. Tests and Inspections:
 1. Schedule, obtain, and pay for permits and fees required by local authorities and by these specifications.

2. Request for Tests: Notify the Contracting Agency a minimum of 24 hours in advance of tests. In the event the Contracting Agency does not witness the test, certify in writing that all specified tests have been made in accordance with the specifications.
3. Deficiencies: Immediately correct deficiencies that are evidenced during the tests and repeat tests until system is approved. Do not cover or conceal electrical installations until satisfactory tests are made and approved.
4. Operating Tests: Upon request from the Contracting Agency, place the entire electrical installation and/or any portion thereof, in operation to demonstrate satisfactory operation.
5. The Contracting Agency may inspect and approve sample installation of systems and equipment prior to general installation of units.
6. Test Witness: Arrange for the Contracting Agency to witness tests. The Contracting Agency may waive witnessing any specific test at its discretion.
7. Tests: During final inspection, conduct operating tests for approval. Demonstrate installation to operate satisfactorily in accordance with requirements of Contract Documents. Should any portion of installation fail to meet requirements of Contract Documents, repair or replace items failing to meet requirements until items can be demonstrated to comply. Have instruments available for measuring light intensities, voltage, and current values and for the demonstration of continuity, grounds, or open circuit conditions. Furnish personnel to assist in taking measurements and making tests. In the event that systems are not complete and fully operational at the time of final inspection, all costs of any subsequent inspections shall be borne by the Contractor at no additional cost to the Owner.
8. Certificate of Completion: Submit at time of request for final inspection, a complete letter in _____ the _____ following _____ format:
I, _____ (Name), of _____ (Firm), certify that the electrical work is complete in accordance with Contract Plans and Specifications, and authorized change orders (copies of which are attached hereto) and will be ready for final inspection as of _____ (Date). I further certify that the following Specifications requirements have been fulfilled:
 - a. Megger readings performed, ____ copies of logs attached.
 - b. Operating manuals completed and instruction of operating personnel performed, _____ (Date) _____ (Signed)

Owner's Representative
 - c. Record document drawings up-to-date, accurate, and ready to deliver to Contracting Agency.
 - d. Emergency systems tested and fully operational.
 - e. Fire Alarm System tested and fully operational.
 - f. Security System tested and fully operational.
 - g. Telecommunications System test reports have been submitted to and approved by the Contracting Agency. The test reports shall certify that the Telecommunications System is complete, passes all test criteria, is fully operational, and that all work has been witnessed as specified.
 - h. Generation System and controls tested and fully operational.
 - i. Intercom/Clock System tested and fully operational.

- j. Ground-fault system performance test complete, copies of logs attached.
- k. Other tests required by Specifications have been performed.
- l. Specified Owner training complete.
- m. Systems are fully operational. Project is ready for final inspection.

SIGNED: _____ DATE: _____
TITLE: _____

- 9. Operating Instructions: Prior to final acceptance, instruct an authorized representative of the Owner for eight hours on the proper operation and maintenance of electrical systems and equipment provided under this contract. This requirement is for several systems, and is in addition to special training specified in other sections. Make available a qualified technician for each component of the installation for this instruction. Give these operating instructions after the operation and maintenance manuals have been furnished to the Owner. Submit written certification, signed by the Contractor and an authorized representative of the Owner, that this has been completed.

1.7 WARRANTY

- A. Warranty work shall be promptly coordinated and performed at the Contractor's sole expense. Workmanship, labor and materials (without limitation) in this Division shall be warranted for the longer of the following:
 - 1. As called for in the General Conditions of the Contract.
 - 2. For a minimum period of one year from the date of final acceptance.
 - 3. For the extended warranty period specified in a specific Section under this Division.
- B. Where a specific product carries a longer warranty as a standard offering of its manufacturer, extended warranty coverage beyond these requirements shall be retained by the Owner. The Owner will have recourse back to the manufacturer only in these cases, when the warranty as specified in A above has expired.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT FURNISHED IN DIVISIONS 26, 27 AND 28

- A. Materials furnished and installed in permanent construction shall be new, full-weight, standard in every way, and in first class condition.
- B. Materials shall conform to the standards of an organization acceptable to the Authority Having Jurisdiction and concerned with product evaluation that maintains periodic inspection of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. Only materials designed for the purpose employed shall be used.

- C. Materials shall be identical with apparatus or equipment that has been in successful operation for at least two years. Materials of similar class or service shall be of one manufacturer.
- D. Capacities, sizes, and dimensions given are minimums unless otherwise indicated. Systems, materials and equipment proposed for use on this project shall be subject to review for adequacy and compliance with Contract Documents.

2.2 MATERIALS AND EQUIPMENT FURNISHED IN OTHER DIVISIONS

- A. Controls, including conduit, wiring, and control devices required for the operation of systems furnished in other Divisions shall be provided complete under the Division of the Specifications in which the equipment is specified, unless otherwise noted or specified.
- B. Work on the project that falls under the jurisdiction of the electrical trade shall be performed by Licensed Electricians in conformance with the electrical specifications.
- C. Provide complete power connections to equipment including but not limited to feeders, connections, disconnects and motor running overcurrent protection. Where starters are provided as part of packaged equipment, overcurrent heaters shall be provided under Divisions 26, 27 and 28.

PART 3 - EXECUTION

3.1 COORDINATION WITH ROOM NUMBERING

- A. Certain systems provided under this Division rely on identification systems that are based on room names or numbers. Systems labeled in this fashion include, but are not limited to, panelboards, circuit directories, communication and data systems identifiers, fire alarm systems, etc.
- B. The numbering scheme indicated in these Contract Documents is based on room numbers assigned during the design process. The Owner reserves the right to change the numbers prior to substantial completion, and the final names and numbers will not necessarily match those found in the Documents. Obtain from the Owner the final room numbers prior to commencing the numbering of Divisions 26, 27 and 28 systems. Tag and label all system circuits and devices in accordance with the final numbering scheme at no additional cost.

3.2 INSTALLATION

- A. Skilled craftsmen shall install materials and equipment. The norms for execution of the work shall be in conformity with NEC Chapter 3 and the National Electrical Contractors' Association "National Electrical Installation Standards", which herewith is made part of these specifications.
- B. Repair surfaces and furnish all required material and labor to maintain fireproof, airtight and waterproof characteristics of the construction.
- C. Installation of equipment shall be in accordance with manufacturers' instructions.

3.3 MULTIWIRED BRANCH CIRCUITS

- A. Multiwire branch circuits shall not be used on this project. Each branch circuit shall be provided with its own dedicated neutral conductor.

3.4 MOUNTING HEIGHTS

- A. Mounting height shall be to center of box above finished floor (AFF) as noted below unless otherwise shown or indicated. Other mounting heights are indicated on the Drawings by detail. Specific dimensions AFF are shown adjacent to the symbol. Where devices are shown on architectural elevations, the elevation height shall govern.

Lighting switches	48 inches
Convenience outlets and similar devices	18 inches (see note below)
Convenience outlets in mechanical, boiler rooms and workrooms	48 inches
Motor controllers	60 inches to top
Panelboards	76 inches to top
Telephone panels	72 inches to top
Bracket lights	84 inches
Exterior WP convenience outlets	24 inches AFG
Clock hanger outlets and clocks	90 inches
Clock/speaker units	90 inches
Speakers	90 inches
Telecommunications (Data/Telephone) outlets	18 inches (see note below)
Range outlets	6 inches (or as required for access through drawer)
Dryer outlets	36 inches
Welder outlets	48 inches
Doorbell push buttons	48 inches
Wall mounted audible and/or visual appliances such as bells, horns, strobes and similar signal devices	90 inches (or 6 inches below ceiling height for ceiling heights less than 96 inches)
Manual fire alarm box	48 inches (or 48 inches to operable part where operable part of device is above centerline of device)
Fire alarm control panel	72 inches to top
Fire alarm graphic annunciator	72 inches to top
Fire alarm text annunciator	60 inches to center
Security Keypad	60 inches to center

Security Card Reader	48 inches to center
Nurse call annunciator	72 inches to top
Nurse call switches	48 inches
Intercom handsets and call-in switches	60 inches
Intercom administrative phone outlets	18 inches (see note below)

- B. NOTE: In locations where baseboard-heating enclosures are to be installed, outlet-mounting height shall be raised to 6 inches above top of enclosure unless otherwise noted on drawings.

3.5 CUTTING & PATCHING

- A. Obtain written permission of the Contracting Agency before cutting or piercing structural members.
- B. Wall and floor penetrations shall be in accordance with Section 260529 - Hangers and Supports.
- C. Holes through existing concrete shall be core drilled. X-ray concrete before core drilling. Do not cut rebar without specific authorization from the Contracting Agency. Seal openings with UL Listed fire resistant resilient sealant.

3.6 VAPOR RETARDER/BARRIER PENETRATIONS

- A. Provide solid blocking installed flat at all vapor retarder penetrations. Provide flat blocking at the interior face of the exterior stud wall. Blocking shall be a minimum of 4 inches larger than the penetration. Locate the penetration at the centerline of the flat blocking. Secure vapor retarder to blocking.
- B. Seal the interior of raceways penetrating the vapor retarder inside the building. Between point of sealing inside of raceway (typically at junction box or conduit) and vapor retarder penetration, seal conduit joints (connectors and couplings) with vapor retarder tape, paint on sealer or approved means acceptable to Contracting Agency.
- C. Penetrations of the building vapor retarder/barrier caused by the electrical installation shall be minimized, and where they are required, the opening in the vapor retarder/barrier shall be cut smaller than the penetrating object, so that the penetration will be a stretch fit. The penetration shall then be securely sealed with vapor barrier tape or an adhesive or caulk compatible with the surfaces being sealed.
- D. Boxes (electrical boxes, outlet boxes and telecommunication boxes, etc) penetrating walls with vapor retarder/barriers shall be sealed airtight using STI Series SSP Firestop Putty Pads. Mold putty pads around electrical junction boxes and conduits and behind vapor retarder/barrier to form an airtight seal in accordance with manufacturer's installation instructions.

3.7 FIRE RESISTIVE CONSTRUCTION

- A. Provide "tenting" or other protection acceptable to the Authority Having Jurisdiction for devices or fixtures installed in fire resistive construction (i.e., ceilings, walls, etc.) to maintain the fire resistive rating of the complete assembly.
- B. Where electrical raceways or other features penetrate fire rated building surfaces, they shall maintain the integrity of the building surface being penetrated. This shall be accomplished with either of the following methods:
 - 1. Sealing the penetration with an approved fire rated caulk or putty.
 - a. Fire rated caulk or putty: 3M Fire Barrier Caulk No. CP25, 3M Fire Barrier Moldable Putty, or as approved.
 - 2. A fire rated assembly enclosing the penetration.
 - a. Fire rated assembly: STI EZ Path, or as approved.
 - 3. Firestopping shall be applied according to the manufacturer's recommendations, and in a manner that is listed by a nationally recognized independent testing agency (such as UL) as preserving the fire time rating of the construction.

3.8 SOUND ISOLATION

- A. Where electrical raceways or other features penetrate walls that extend to structure, they shall maintain the integrity of the building surface being penetrated. Refer to the requirements of FIRESTOPPING as specified above. Note that this requirement exists regardless of whether the building surface being penetrated has a fire rating.
- B. Boxes (electrical boxes, outlet boxes and telecommunication boxes, etc) penetrating wall types that extend to structure or that contain batts shall be sealed airtight using STI Series SSP Firestop Putty Pads to reduce sound transmission. Mold putty pads around electrical junction boxes and conduits to form an airtight seal in accordance with manufacturer's installation instructions.

3.9 PROTECTIVE FINISHES

- A. Take care not to scratch or deface factory finish of electrical apparatus and devices. Repaint all marred or scratched surfaces.
- B. Provide hot dip galvanized components for ferrous materials exposed to the weather.

3.10 SEPARATION OF SYSTEMS

- A. Conductors and equipment of different voltage levels, frequency, current characteristics (AC & DC) or functions (normal vs. emergency, etc.) shall not share the same raceways or enclosures unless specifically shown on the Drawings or approved by the Contracting Agency, or inherently necessary for correct system function (i.e., at transfer switches, transformers, etc.)

3.11 TESTING

- A. Prior to final test, switches, panelboards, devices and fixtures shall be in place.
- B. Test electrical systems. They shall be free from short circuits and unintentional grounds.
- C. Make changes necessary to balance the actual electrical loads on the complete system. Arrange for balanced conditions of circuits under connected load demands, as contemplated by the normal working conditions. Final load and balance test shall be demonstrated in the presence of the Contracting Agency.
- D. Feeder cables and branch circuit cables larger than #4 AWG shall be megger tested prior to final termination. If conductor fails test, replace wiring or correct defect and retest. Perform a 1,000 volt megohm meter test between the following circuit cables in each raceway:
 - 1. A phase and B phase conductors
 - 2. A phase and C phase conductors
 - 3. B phase and C phase conductors
 - 4. A phase and Grounded (Neutral) conductors
 - 5. B phase and Grounded (Neutral) conductors
 - 6. C phase and Grounded (Neutral) conductors
 - 7. A phase and Equipment Grounding conductors
 - 8. B phase and Equipment Grounding conductors
 - 9. C phase and Equipment Grounding conductors
 - 10. Grounded (Neutral) and Equipment Grounding conductors
- E. Feeder cables shall be megger tested prior to final termination. If conductor fails test, replace wiring or correct defect and retest. Perform a 1,000 volt megohm meter test on each circuit cable rated 600 volts between the conductor and ground. Submit logs of megger readings. The insulation resistance between conductors shall not be less than 100 Megohms.
- F. Furnish one (1) copy of certified test results to the Contracting Agency prior to final inspection.

3.12 STORAGE AND HANDLING

- A. Items shall be delivered and stored in original containers, which shall indicate manufacturer's name, the brand, and the identifying number. Items subject to moisture and/or thermal damage shall be stored in a dry, heated place. Items shall be covered and protected against dirt, water, chemical, ultraviolet (UV) and/or mechanical damage.

3.13 PROTECTION OF MATERIAL AND EQUIPMENT

- A. The Contractor shall be responsible for materials and equipment to be installed under this Contract. The Contractor shall make good at his own cost any injury or damage which said materials or equipment may sustain from any source or cause whatsoever before final acceptance.
- B. Cover and protect electrical equipment during construction from dust, dirt, debris, overspray, or other construction contaminants.

3.14 CLEANING AND REPAIR

- A. Throughout the work, the Contractor shall keep the work area reasonably neat and orderly by frequent periodic cleanups.
- B. Prior to substantial completion, clean equipment and systems used during construction.
- C. Repair surfaces damaged or impacted by the work. Restore to original condition or better. Retexture surfaces to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish.
- D. As independent parts of the installation are completed, they may be tested and utilized during construction.

3.15 ACCESS DOORS

- A. Provide access doors required for access to equipment provided under Divisions 26, 27 and 28. Doors shall be rated for the surrounding construction. Use of access doors shall be minimized, and all locations and cosmetic features shall be submitted for approval in advance.
- B. Doors shall be finished to match surrounding surfaces as approved by the Contracting Agency.

END OF SECTION 260000

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SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes specific requirements, products, and methods of execution relating to wire and cable, 600 volts or less, approved for use on this project.
- B. Related Sections
 - 1. 260533 - Raceways and Boxes for Electrical Systems
 - 2. 260553 - Identification for Electrical Systems

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.3 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.

1.4 QUALITY ASSURANCE

- A. Conductors shall be sized according to American Wire Gauge (AWG). Stranding, insulation, rating and geometrical dimensions shall conform to UL and ICEA specifications.

PART 2 - PRODUCTS

2.1 INSULATION TYPES

- A. Branch circuit conductors shall be 600 volt insulated, and unless otherwise noted on the Drawings, shall have the following insulation types:
 - 1. Heated indoor spaces - THHN/THWN or XHHW.
 - 2. Outdoors, wet locations (such as slab-on-grade), or other cold locations (such as unheated attics) - XHHW.
- B. Feeder conductors shall be 600 volt insulated, and unless otherwise noted on the Drawings, shall have the following insulation types:
 - 1. Heated indoor spaces - THHN/THWN or XHHW-2.
 - 2. Outdoors, wet locations (such as slab-on-grade), or other cold locations (such as unheated attics) - XHHW-2.
- C. Nylon-jacketed conductors such as Types THHN or THWN shall not be used in any location subject to ambient temperatures below 20° F.
- D. Special applications: Conductors in fluorescent fixture wiring channels shall have 90° C insulation rating, Types THHN, XHHW, or equal. Conductors in high temperature locations shall have one of the special insulation types suitable for the use and as permitted by the NEC.

2.2 MC CABLE

- A. Where concealed, type MC (metal clad) cable is acceptable on this project for branch circuit wiring. Type MC cable shall not be used for branch circuit homeruns. Homerun shall be considered to originate within 10 feet of the last device or fixture connection or as approved by the Contracting Agency.
- B. Type MC (metal clad) cables shall have integral code-sized grounding conductor.
- C. Type MC cable shall consist of a factory assembly of one or more conductors, each individually insulated and enclosed in a metallic sheath of interlocking tape or a smooth corrugated tube.

2.3 TYPE RHH, 2-HOUR FIRE RATED CABLE

- A. Where required by fire pumps, Type RHH, 2-hour fire rated cable is acceptable on this project. Submit for approval, prior to installation, all intended applications. Type RHH, fire rated cable shall be installed in adequately sized GRC conduit, unless otherwise approved. Cable installed without prior approval is subject to removal at the Contractor's expense at the discretion of the Contracting Agency.
- B. Type RHH, 2-hour fire rated cable specifications.
 - 1. UL listed Type RHH, 2-hour fire cable (600V, 90 C temperature rating).

2. Meets requirements of UL 2196.
3. No cable length restrictions.
4. Requires no special tools, connectors, or procedures to install.

2.4 FLEXIBLE CORD

- A. Flexible cord shall be Type SO or ST, or for the larger sizes, Type G.

2.5 MISCELLANEOUS

- A. Miscellaneous: Miscellaneous wire and cable for special purpose applications and not covered in the categories as indicated above or otherwise specified, shall be as shown on the plans and/or required by the intended use.

2.6 MINIMUM SIZE

- A. Unless specified otherwise minimum wire sizes shall be as follows:
 1. #12 AWG for branch circuit wiring.
 2. #20 AWG for low voltage switching circuits if part of an approved cable assembly, #18 AWG otherwise.
 3. #14 AWG for control circuit wiring.
 4. #16 AWG for light fixture whips, refer to specification section 260533 - Raceway and Boxes for Electrical Systems, for maximum fixture whip lengths.
- B. On 20A circuits, with one-way conductor lengths measured from panel to farthest receptacle, or center of lighting string (as applicable):
 1. #10 AWG for 120V circuits of 75 feet to 120 feet.
 2. #8 AWG for 120V circuits of 120 feet to 200 feet.
 3. #10 AWG for 277V circuits of 130 feet to 215 feet.
 4. #8 AWG for 277V circuits of 215 feet to 330 feet.
- C. Similar oversizing shall apply to circuits of other ratings and/or greater lengths, as necessary to comply with the voltage drop limitations in Part 3 of this Section.
- D. Cable or conductors for fire alarm systems and other special systems shall be as described in other sections of the specifications, noted on the drawing, or recommended by the equipment manufacturer, whichever is greater.

2.7 CONDUCTORS

- A. Conductors used on this project shall be copper, solid or stranded for wiring #10 and smaller, stranded for #8 and larger.
- B. Aluminum conductor of an equivalent ampacity may be used in sizes #4 and larger. Conductor size shall be increased if required to maintain original voltage drop. Conduits shall be re-sized accordingly to maintain original fill ratio.
- C. Stranded control, communication, and alarm conductors shall have compression terminations where terminated on screw terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Unless otherwise noted or specified, all conductors shall be run in raceways as specified in Section 260533 – Raceways and Boxes for Electrical Systems. Raceways shall be installed as a complete system, free from obstructions, and clean before conductors are installed.
- B. Provide conductors from outlet to outlet and splice branch circuit conductors only at outlet or junction boxes. Install all conductors in a single raceway at one time and leave sufficient cable at all fittings or boxes. Keep conductors within the manufacturer's allowable tension. Do not violate minimum bending radii. Lubricants for wire pulling, if used, shall conform to UL requirements for the insulation and raceway material.
- C. Do not install Type XHHW conductors in temperatures below -10° F, or the other types in temperatures below +20° F.
- D. Conductors that extend below grade shall be suitable for wet locations (type XHHW or XHHW-2). The use of THHN below grade is not acceptable.

3.2 CONDUCTOR SUPPORT

- A. Provide conductor supports as recommended by the NEC or cable manufacturer in vertical conduits.

3.3 SPLICING

- A. No splicing or joints are permitted in branch circuits except at outlet or accessible junction boxes. Prior to splicing, conductors shall be stripped to the exposed length recommended by the splicing device manufacturer.
- B. Utilize compression type solderless connectors when making splices or taps in conductors No. 8 AWG or larger. Provide heat or cold shrink type insulating tubing on splices and tape outer surface continuously with Scotch #88 plastic tape to secure insulation strength equal to that of the conductors joined.

- C. Utilize pre-insulated connectors, hard-shell type only, Ideal Industries, Inc., "Wing-Nut" or "Twister Pro" or "In-Sure Push-in Connectors" for splices and taps in conductors No. 10 AWG and smaller in dry locations.
- D. Utilize Ideal "Twister DB Plus", water repellent, sealant filled, UL 486D Listed connector splices and taps in conductors No. 10 AWG and smaller in damp or wet locations.
- E. Utilize "Buchanan pre-insulated crimp connectors" on stranded conductors for fire alarm control and alarm circuits.
- F. Keep splices in underground junction boxes, handholes, and manholes to an absolute minimum. Use resin splicing kits manufactured by 3M Company to totally encapsulate the splice.
- G. Feeder conductors shall be installed with no splices unless otherwise noted on the Drawings. Splices in feeder conductors, where specifically allowed, shall be compression type butt splices.

3.4 CONDUCTOR TERMINATION

- A. Provide power and control conductors that terminate on equipment or terminal strips with solderless lugs or T & B "Sta-Kon" terminals.
- B. Prior to termination, conductors shall be stripped to the exposed length recommended by the termination device manufacturer.

3.5 CONDUCTOR PHASE COLOR CODING

- A. Service, feeder and branch circuit conductors throughout the project secondary electrical system shall be color coded as follows:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray (see following)
Green	Ground	Green

- B. Where color coded conductors are not commercially available, colored non-aging, plastic tape may be utilized where permitted by NEC.
- C. Where neutrals of different systems exist on the project, neutral conductor identification method shall satisfy the Authority Having Jurisdiction, as to compliance with NEC Article 200. Branch circuit neutral conductors shall have a color stripe matching the corresponding phase conductor where neutral is not shared.

- D. Phases in panelboards and similar equipment shall be connected Phase A, B, C from left to right, top to bottom, or front to back.

3.6 DERATING OF CONDUCTORS

- A. Derating of conductors shall be per National Electrical Code.

3.7 VOLTAGE DROP

- A. The maximum total voltage drop shall not exceed three (3) percent in branch circuits or feeders, for a total of five (5) percent to the farthest outlet based on steady state design load conditions. Wire sizes shown on the Drawings are for minimum ampacity. Wire and conduit sizes shall be increased to limit voltage drop based upon actual lengths required in the field. Base voltage-drop calculations on NEC Chapter 9, Table 9.
- B. Secondary transformer voltage taps may be used to offset voltage drop as long as no load voltage does not exceed 125 volts at transformer secondary.

3.8 OPEN WIRING ABOVE LAY-IN CEILINGS PROHIBITED

- A. Wiring for all systems shall be installed in one of the raceway systems or cable tray systems listed for this project. Refer to the Drawings and the specific Section under which each system is specified.
- B. Wiring installed in cable trays in air-handling ceiling spaces shall be approved for the application and the specific system.
- C. Raceways and sleeves shall be sized in accordance with the cabling requirements for the special system involved.

3.9 TESTING

- A. Feeder and branch circuit cables larger than #4 AWG shall be megger tested prior to final termination in accordance with Section 260000 – Electrical General Requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general requirements, products and methods of execution relating to the furnishing and installation of a complete grounding system as required for this project.

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only, latest edition.

NUMBER	TITLE
ANSI/IEEE C2	National Electrical Safety Code
ANSI/NFPA 70	National Electrical Code
ANSI/TIA/EIA 606-A	Administration Standard for Commercial Telecommunications Infrastructure
ANSI/TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications
IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage Surge Protective Devices
IEEE C62.42	Guide for the Application of Gas Tube Arrester Low-Voltage Surge Protective Devices
IEEE Draft P1250 (D4)	Guide on Service to Equipment Sensitive to Momentary Voltage Disturbances
IEEE Std 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
IEEE Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE STD 81	Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth
NFPA 70	National Electric Code (NEC) - Codebook and Handbook
REA PE-33	(1985) Shield Bonding Connectors
UL 1449 Edition 3	Surge Protective Devices (SPDs)
UL 467 Edition 6	Grounding and Bonding Equipment
UL 497 Edition 5	Protectors for Paired Conductors for Communication Circuits
UL 497A Edition 1	Secondary Protectors for Communication Circuits
UL 497B Edition 1	Protectors for Data Communication and Fire Alarm Circuits

1.3 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1. Include copies of catalog cuts, data sheets and other descriptive information for all specified materials.

1.4 MINIMUM REQUIREMENTS

- A. The minimum requirements for the system shall conform to Article 250 of the NEC.

1.5 SPECIAL REQUIREMENTS

- A. Unless specified elsewhere, the ohmic values for grounds and grounding systems shall be as follows:
 - 1. For grounding metal enclosures and frames for electrical and electronically operated equipment -- 5 ohms maximum.
 - 2. For grounding systems to which electrical utilization equipment and appliances are connected -- 5 ohms maximum.
 - 3. For grounding secondary distribution systems, neutrals, noncurrent carrying metal parts associated with distribution systems, and enclosures of electrical equipment not normally within reach of other than authorized and qualified electrical operating and maintenance personnel -- 10 ohms maximum.

1.6 TELECOMMUNICATIONS GROUNDING SYSTEM

- A. Telecommunications ground systems shall be provided as shown on the Contract Drawings and as related herein.
 - 1. Telecommunication Bonding Backbone (TBB) - A copper conductor extending from the telecommunications main grounding busbar (TMGB) to each telecommunications grounding busbar (TGB).
 - 2. Telecommunications Main Grounding Busbar (TMGB) - The TMGB serves as a dedicated extension of the building grounding electrode system for telecommunications infrastructure. The TMGB is generally located in the main telecommunications entrance room or as shown on the Drawings.
 - 3. Telecommunications Grounding Busbar (TGB) - A busbar placed in a convenient and accessible location in a Telecom Room (TR) that is connected back to the TMGB. All equipment served from the TR shall be connected to the local TGB.
 - 4. Site grounding system - connecting the TMGB in each structure to the low resistance earth grounding system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Grounding conductors, ground rods, and equipment required for ground systems shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL), and be in accordance with U.L. 467 and as follows:
 - 1. Ground rods shall be 3/4 inch by 10 foot copper bonded steel. Erico Eritech or approved equal.
 - 2. Grounding conductors shall be copper. Unless specified otherwise, raceway for service grounding conductor shall be Schedule 40 PVC.
 - 3. Grounding conductor for telephone service entrance and telephone/data panels shall be #6 insulated copper, with 6 feet-0 inches slack cable at each panel. Comply with intersystem bonding requirements of NEC.
 - 4. Grounding conductor for television and radio distribution systems shall be #6 AWG insulated copper. Comply with intersystem bonding requirements of NEC.

2.2 CONNECTIONS

- A. Joints in grounding conductors and mats below grade shall be made with exothermic welding process or hydraulically crimped fittings listed for direct burial. Terminations above grade shall be made with solderless lugs, securely bolted in place unless noted otherwise on the Drawings or telecommunications sections
- B. Clamps, lugs, connectors, bonding bushings, and other such grounding and bonding items shall be:
 - 1. Labeled or listed for the purpose.
 - 2. Shall be made (both body and hardware) of hot dip galvanized steel, bronze, or other corrosion resistant alloy (except bushing throats shall be plastic).
 - 3. Shall be the products of O-Z/Gedney, T & B, Raco, or accepted equals.
 - 4. In outdoor, damp, or corrosive environments, metals for these items shall be copper (with or without tin-plating), bronze, or other corrosion resistant alloys only; O-Z/Gedney or accepted equal.

2.3 TELECOMMUNICATIONS GROUNDING SYSTEMS

- A. Telecommunications Bonding Backbone (TBB):
 - 1. The TBB shall be a green 6 AWG minimum 600 volt insulated copper conductor. The minimum size of each TBB shall be such that the total DC resistance back to the TMGB is less than 0.10Ω.

2. Cable supports shall be strut with distribution rings.
- B. Grounding Busbars shall be Cadweld P/N B544A028, 1/4 inch by 4 inches by 16 inches copper with lug patterns for #8 through 1000 KCMIL conductors. Grounding busbars shall be electrolytic copper and mounted on fiberglass insulators rated at 2,700V.
 1. Provide one Grounding Busbar for each:
 - a. Telecommunications Main Grounding Busbar (TMGB).
 - b. Telecommunications Grounding Busbar (TGB).

2.4 TELECOMMUNICATIONS SYSTEM BONDING

- A. Bond telecommunication equipment chassis, ladder racks, cable trays, conduits, equipment frames, cabinets, and all other telecommunication room and equipment room metallic components to a local TGB with green #6 AWG, 600 volt, insulated copper conductor. Each piece of equipment shall be connected back to the local TGB in a radial configuration, i.e., equipment ground connections shall not be "daisy chained" and then connected to TGB.
- B. Bonding of grounding conductors shall be with the following methods as specified herein:
 1. Connections to grounding busses: Cool Amp Plating, field applied to both surfaces for bolted and compression connections.
 - a. Approved gas tight two hole copper grounding compression lugs T&B 54205 series 2 hole, crimp Cool Amp plated compression type for connection to grounding busses.
 - b. Fasteners shall be nickel plated steel nuts, bolts and lockwashers.
 2. Conductor splices and connection to ground rods:
 - a. Cadweld exothermic welds. Bonds below grade shall be exothermic or hydraulically crimped fittings listed for direct burial.
 - b. Burndy type "YG" extruded wrought copper prefilled with Pentrox heavy duty compression connectors with probe holes (Type YGA and YGS not acceptable).
- C. Connections made to static dissipative tile grounding systems shall be made per the manufacturer's recommendations. Route grounding conductors in approved conduits.

2.5 IDENTIFICATION AND LABELING

- A. Grounding conductors shall be labeled in accordance with TIA/EIA-606-A.

PART 3 - EXECUTION

3.1 SERVICE GROUND

- A. Create an equipotential plane for the grounding system for this project at the service entrance equipment by connecting the following to the service entrance ground bus:
 - 1. The commercial system's grounded neutral conductor and, if installed, the standby generator frame.
 - 2. All metallic water services to the building.
 - 3. All grounds specified to be installed.
 - 4. The service entrance equipment and conduits entering and leaving the equipment.
 - 5. The metallic piping systems in the building.
 - 6. The metallic gas piping system upstream from the equipment shutoff valve.
 - 7. Concrete encased electrode, "Ufer ground," as further specified in this Part.
 - 8. Structural steel columns as noted elsewhere in this section.
 - 9. Other items or equipment called for on the Drawings.
- B. Ground the Emergency Generator in accordance with the requirements for a "Separately Derived System." (The transfer switches also switch the neutral.)
- C. Current carrying capacity of the grounding and bonding conductors shall be in conformity with Table 250.66 of the NEC. Exception: The bonding conductor for metallic gas piping shall be sized in accordance with Table 250.122 based on the largest overcurrent device protecting feeder conductors exiting the main distribution switchboards.
- D. Measure resistance to earth of service grounds by the fall of potential method per IEEE STD 81 "Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth". Record and submit test readings.

3.2 EQUIPMENT GROUND

- A. The raceway system shall be bonded in conformity with NEC requirements to provide a continuous ground path. Where required by Code or Ordinance or where called for on the plans an additional grounding conductor shall be provided, sized in conformity with Table 250.122 of the NEC, unless larger size is noted.
- B. Provide separate grounding conductor securely bonded and effectively grounded to the enclosures at both ends of all non-metallic raceways and all flexible conduit.
- C. Provide an equipment grounding conductor sized in conformity with Table 250.122 of the NEC, unless larger size noted, for all feeder and branch circuit conduits. Where conductors

are adjusted in size to compensate for voltage drop, equipment grounding conductors shall be adjusted proportionately according to circular mil area.

3.3 CORDS AND NONMETALLIC CABLES

- A. Unless specifically permitted otherwise, cords and nonmetallic cables shall be furnished with integral Code-sized grounding conductor. Securely bond metal components and effectively ground the entire electrical system.

3.4 ELEVATOR/ESCALATOR EQUIPMENT

- A. Provide a Code sized ground conductor to the elevator/escalator equipment in accordance with "Safety Code For Elevators and Escalators", ANSI/ASME A17.1.

3.5 TELECOMMUNICATIONS GROUNDING SYSTEM

A. Service Ground:

1. Provide connection to the electric power service ground. The Main Grounding Conductor from the TMGB shall be as shown on the Drawings.
2. Measure resistance to earth of service ground as described in Part 3.
3. Coordinate all outages and ground well installations with the Contracting Agency.

B. Telecommunications Bonding Backbone (TBB):

1. Connect the TBB between each TGB and the TMGB in a star configuration to minimize ground loops.

C. Telecommunications Main Grounding Busbar (TMGB):

1. Equipment and metallic raceways located in the same room as the TMGB shall be bonded to the TMGB. Each piece of equipment shall be connected back to the TMGB in a radial configuration, i.e., equipment ground connections shall not be "daisy chained" and then connected to TGB.
2. TBB connections to the TMGB shall be made with listed 2 hole compression connectors or exothermic type welded connections. Each piece of equipment shall be connected back to the local TGB in a radial configuration, i.e., equipment ground connections shall not be "daisy chained" and then connected to TGB.
3. Where a panelboard for telecommunications is located in the same room as the TMGB, the panelboards Alternating Current Equipment Ground (ACEG) bus or the enclosure shall be bonded to the TMGB.
4. Connect the TMGB to the service entrance ground bus with a bolted lug connection.

D. Telecommunications Grounding Busbar (TGB):

1. Equipment and metallic raceways located in the same room as the TGB shall be bonded to the TGB.
2. TBB connections to the TGB shall be made with listed 2 hole compression connectors or exothermic type welded connections.
3. Where a panelboard for telecommunications is located in the same room as the TGB, the panelboards Alternating Current Equipment Ground (ACEG) bus or the enclosure shall be bonded to the TGB.

E. Bonding and Connections:

1. General:
 - a. Cadweld exothermic welds. Bonds concealed or below grade shall be exothermic or hydraulically crimped fittings listed for direct burial.
 - b. Compression connections shall be made using a hydraulic 4 way compression die.
 - c. Compression connections shall be exposed unless UL Listed for direct burial.
 - d. Insulated wire splices shall be insulated with preformed wire covers.
2. To Building Steel:
 - a. Cadweld connections to building steel.

F. Identification and Marking:

1. Show conductors on neatly marked record drawings. Submit to the Contracting Agency.
2. Grounding conductors shall be marked per ANSI/TIA/EIA 606-A and as directed by the Contracting Agency. Mark each cable end using tie wrap style cable markers.

3.6 EXTERNAL BONDING JUMPERS

- A. Not permitted; bonding jumpers shall be run inside the raceways for the circuits they serve.

3.7 CONCRETE ENCASED ELECTRODES, "UFER GROUNDS"

- A. Concrete Encased Electrodes, "Ufer Grounds", shall be installed in accordance with NEC 250.52(A).
- B. Unless otherwise noted, Ufers shall be installed in the concrete footing closest to the electrical main service equipment. The Ufer ground shall consist of the grounding electrode conductor itself, extended without splice into the bottom of the footing for at least 20 feet.
- C. Suspend conductor during concrete pour with tie wires such as used on rebar; maintain at least 2 inches of concrete cover. Bond conductor to rebar in at least one location.

3.8 SEPARATELY DERIVED SYSTEMS

A. Separately derived systems shall be grounded in accordance with NEC Article 250.30.

1. Bonding jumper:

- a. The bonding jumper shall be sized in accordance with NEC Table 250.66. Where the derived phase conductors are larger than 1100 kCMIL copper, the bonding jumper shall have an area that is not less than 12-1/2% percent of the area of the largest phase conductor.
- b. The bonding jumper shall be used to connect the equipment grounding conductors of the separately derived system to the grounded conductor.
- c. The bonding jumper shall be located within the enclosure of the source of the separately derived system, unless specifically noted otherwise.

2. Provide termination lugs for the co-located grounded conductor, grounding electrode conductor and bonding jumper terminations, using Listed compression-type connectors suitable for all conductors landed at each location.

3. The grounded conductor of the separately derived system shall be bonded to the nearest available point of the interior metal water piping system in the area served by the separately derived system. The bonding jumper shall be sized in accordance with NEC Table 250.66.

4. Grounding electrode:

- a. The grounding electrode shall be as near as practical to and preferably in the same area as the grounding electrode conductor connection to the system.
- b. The grounding electrode conductor, sized in accordance with NEC Table 250.66, shall be used to connect the grounded conductor of the derived system to the grounding electrode.
- c. The grounding electrode shall be the nearest two of the following:
 - 1). Effectively grounded structural metal member of the structure.
 - 2). Effectively grounded metal water pipe within 5 feet from the point of entrance into the building.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. General hanger and support requirements for electrical equipment, conduit and cable trays not required to be vibration and/or seismically controlled.
2. Penetrations, sleeves and seals.

B. Products Installed But Not Supplied Under this Section:

1. Vibration Isolation and Seismic Control anchoring and support systems furnished under Section 200548 - Mechanical Vibration and Seismic Control.

C. Related Sections:

1. 019100 - Commissioning
2. 200548 - Mechanical Vibration and Seismic Control
3. 260000 - Electrical General Requirements
4. 260533 - Raceways and Boxes for Electrical Systems
5. 262416 - Panelboards
6. 262419 - Motor Control Centers
7. 262900 - Low Voltage Controllers
8. 263213 - Diesel Engine Driven Generator Sets
9. 265000 - Lighting Fixtures
10. 270536 - Cable Trays for Electrical Systems
11. 272010 - Telecom Distribution System
12. Division 3 - Cast-In-Place-Concrete
13. Division 09 - Painting

1.2 REFERENCES

- A. NFPA 70: National Electrical Code (NEC) latest legally enacted edition.

1.3 DESCRIPTION

- A. Provide general hanger and support requirements for electrical equipment, conduit and cable trays not required to be vibration and/or seismically controlled in accordance with the manufacture's written installation instructions and NFPA 70.
- B. Coordinate directly with Section 20 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control to identify electrical equipment and systems which require vibration and/or seismic control bracing in addition to the requirements of this section.

1.4 SUBMITTALS

- A. See Section 260000 - General Electrical Requirements for general submittal requirements
- B. Product Data:
 - 1. Provide manufacturers catalog data for each product specified. Indicate channel gauge and maximum load capacities of the selected products.
 - 2. Manufacturer's Installation Instructions: Include assembly instructions, recommended parts and special procedures as required.
- C. Shop Drawings:
 - 1. Provide a single shop drawing submittal which integrates the shop drawing requirements of this section along with the additional requirements of Section 20 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control.
 - 2. Provide shop drawings for items required by code to be seismically engineered.
- D. Project Record Information:
 - 1. Indicate installed locations of hangers and supports on project as-built shop drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
 - 1. Verify products are delivered in original factory packaging and are free from damage and corrosion.
 - 2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Owner.
- B. Storage and Protection:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.
2. Handle items to avoid damage.
3. Replace damaged items with same item in new condition.

1.6 WARRANTY

- A. Provide warranty in accordance with Section 260000 - General Electrical Requirements.

PART 2 - PRODUCTS

2.1 PRE-ENGINEERED SUPPORT SYSTEMS

A. Manufacturers:

1. Unistrut
2. Super-Strut
3. B-Line
4. K-Line
5. Erico.

B. Material:

1. Cold worked steel.
2. Type 304 stainless steel: Use for PVC, liquid-tight flex, or plastic-coated conduit installed on wood construction in outdoor, damp, corrosive or marine environments.

C. Finish:

1. Heated indoor areas: Pre-galvanized zinc coating.
2. Outdoor areas: Hot dipped galvanized finish. In addition, coat hot dipped galvanized finish channel field cuts with zinc rich paint provided by the support system manufacturer.
3. Painted areas: Paintable galvanizing or phosphatized and primed.
4. Surface metal raceways: U.L. Listed epoxy coating.

D. Channel:

1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.

2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.
- E. Nuts and Hardware:
1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).
 2. Bolts, screws and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).
 3. Finish: Electroplated zinc.
- F. Fittings: Plate steel (ASTM A635). Epoxy or electroplated zinc coating.
- G. Electrical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:
1. Fluorescent fixture hangers.
 2. Outlet box adapters.
 3. Snap-in closures.
 4. Conduit connection plates.
 5. Junction box adapters.
 6. Strut joiners.
 7. "Caddy" fasteners are permitted for support of conduit to concealed metal studs and for conduit concealed above suspended acoustical ceilings.

2.2 SLEEVES, ACOUSTICAL SEALS AND FIRE-STOPPING

- A. See Part 3 - PENETRATIONS.
- B. Sleeves for pipes through fire rated and fire resistive floors and walls, and fire proofing: UL listed prefabricated fire rated sleeves and seals.

2.3 WALL/FLOOR PENETRATION WATER SEALS

- A. Mechanical seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the wall opening.
- B. EPDM seals.
- C. 316 Stainless steel bolts and nuts.
- D. Hot-dipped galvanized or coated sleeve with full water stop flange with continuous weld on both sides.
- E. Manufacturer: Metraflex, Thunderline, Crouse-Hinds, or pre-approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to installation, prepare detailed shop drawings of items required by code to be seismically engineered. Coordinate the location, type and size of hangers and supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs with Architectural and Structural elements.
- B. Submit shop drawings required by this section coordinated with the seismic design and associated shop drawings required by Section 20 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control as a single submittal.
- C. Do not install hangers and supports without approved shop drawings.

3.2 GENERAL INSTALLATION

- A. Install hangers and supports in accordance with manufacturer's instructions, applicable Code requirements (NFPA 70) and approved shop drawings.
- B. See Section 260000 – Electrical General Requirements for electrical equipment wall mounting heights.

3.3 VIBRATION AND SEISMIC CONTROL PRODUCT INSTALLATION

- A. Install vibration isolators, seismic control and wind restraint systems in strict compliance with the manufacturer's written instructions and certified and approved application engineering installation drawings and details in accordance with Section 20 0548 – Mechanical Vibration and Seismic Control.

3.4 INSERT AND ATTACHMENT INSTALLATION

- A. Caution: Project contains cast in place radiant floor heating tubing. Coordinate slab penetration locations so as not to damage tubing.
- B. Inserts
 - 1. Provide inserts or cast-in-place channels for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 4. Use expansion type anchor bolts with pre-cast concrete including concrete masonry units within loading limits of the pre-cast material and anchor bolt manufacturer's recommendations.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
 6. Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.
- C. Attach electrical equipment to structure as follows:
1. Hollow masonry: Toggle bolts.
 2. Solid masonry and concrete: Preset inserts or expansion bolts.
 3. Structural steel: Beam clamps which engage both sides of structural member or have retaining clips or other approved means for positive engagement.
 4. Metal surfaces: Machine screws, bolts or welding.
 5. Wood construction: Wood or sheet metal screws. Bugle head drywall screws or deck screws are not allowed.
 6. Do not use powder actuated fasteners for anchorage in tension applications. Obtain written permission from the Owner prior to using any type of powder powered studs.
 7. Attachment to plaster or gypsum board (sheet rock) not approved. Equipment shall be attached to or supported from structure.

3.5 RACEWAY INSTALLATION

- A. Support raceways using approved types of wall brackets, ceiling trapeze hangers or malleable iron straps utilizing attachment methods described above. "Perforated plumber's strap" is not permitted as a means of support.
- B. Support raceways independent of ceiling systems, piping and ductwork. Exceptions: Lighting fixtures and outlet boxes (i.e. ceiling speaker boxes) specifically designed for attachment to suspended ceiling systems
- C. Support EMT conduit (1-1/2 inch and smaller/dry locations) using hanger rods with spring steel fasteners.
- D. Support cable trays and multi-conduit runs independently from other support systems utilizing double hanger rods at each support point.

3.6 LIGHTING INSTALLATION

- A. General
 1. Attach safety hanger wires to lighting fixtures such that in event of a ceiling suspension system failure, no part of the fixture will drop more than 6 inches below normal ceiling height. Secure each end of each wire with a minimum of three tight wraps.
- B. Fixtures (greater than 20 pounds/non-suspended ceiling applications)

1. Support lighting fixtures from structural members capable of supporting the total weight of the fixture and independent from electrical wiring system. Attach to steel members using approved beam clamps and rods.
- C. Fixtures (suspended ceiling system applications)
1. Provide supplemental safety hanger wires as follows:
 - a. Fixtures (weighting less than 56 pounds): Provide two 12 gauge wires or equivalent chains connected from the diagonal corners of the light fixture housing to the structure above. These wires may be slack.
 - b. Fixtures (weighting greater than 56 pounds): Provide full direct support from the structure above. Attach wires from within 3 inches of each corner of the fixture.
 - c. Pendant-hung lighting fixtures
 - 1). For each fixture, provide direct support from the structure above using a minimum of two 12 gauge wires, equivalent aircraft cable or an approved alternate support system without using the ceiling suspension system for direct support. Securely attach wire/cable to fixture, route through fixture stem and securely attached to structure.
 - 2). Provide loop and hook or swivel hanger assemblies fitted with a restraining device to secure stem in the support position during earthquake motion.
 - 3). Support fluorescent fixtures with flexible hanger device at the attachment point to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

3.7 PENETRATIONS

- A. Coordinate electrical penetrations with architectural, structural and mechanical construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
- B. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
- C. Penetrations through roof, exterior walls and floors shall be weather and water tight (see floor penetration seals).
- D. Firestopping: Provide UL rated firestopping assemblies for rated roof, wall and floor penetrations in accordance with Division 7.
- E. Conduit Sleeves
 1. Provide sleeves for conduit passing through floors, ceilings, roofs, or fire-rated walls.
 - a. Fabricate sleeves in non-load bearing walls from 20 gauge galvanized sheet steel conforming to ASTM A 924/A 924M.
 - b. Fabricate sleeves in load bearing walls from standard weight galvanized steel pipe conforming to ASTM A 53/A 53M.
 - c. Provide 1/2 inch clearance between conduit and sleeve opening.

2. Provide escutcheons for conduit passing through walls, floors and ceilings in finished areas, below counters and inside closets and casework subject to view when doors are open. Size escutcheons to cover sleeves. Secure escutcheons in position.

F. Acoustical Seals

1. Monolithic sound walls (i.e. poured concrete or masonry): Provide wall sleeve with approximately one-inch annular space around conduit. Pack annular space with backer rod or acoustical filler as specified in Division 7. Allow a 1 inch recess at each end of sleeve. Caulk sleeve flush with flexible sealant or fire-stopping material as specified in Division 7.
2. Where acoustical wall is a two component type, such as a staggered or double stud partition, treat each component as a separate wall. Pack and seal each half of penetration sleeve as previously specified, except that only the exposed end of each sleeve portion shall be caulked with sealant or firestop. Provide adequate separation between each sleeve.

G. Wall Penetration Seals

1. Provide pre-engineered wall penetration water seal systems for exterior wall penetrations.
2. Select appropriate wall penetration sealing systems based on conduit material and nominal conduit size in accordance with the manufacturer's selection charts.
3. Install conduit and sealing system prior to waterproofing the wall. Grout void between water seal and outside face of foundation wall to provide continuous bearing surface for waterproofing fabric.

H. Floor Penetration Seals

1. Provide pre-engineered floor penetration water seal systems for conduit floor penetrations in rooms where a pipe leak/failure could result in water damage to adjacent spaces (i.e. mechanical rooms located above the ground floor or basement) and other areas as noted.
2. Extend conduit floor penetration sleeves 2 inches above finished floor.

3.8 ROOF FLASHING

- A. Provide EDPM pipe penetration and roof curb flashing in accordance with Division 7 as an integral part of the roofing system.

3.9 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FT checklists in accordance with Section 019100 - Commissioning.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes specific requirements, products, and methods of execution relating to conduit, conduit fittings, surface raceways, multi-outlet assemblies, wireways, outlet boxes, pull boxes and junction boxes approved for use on this project. Type, size and installation methods shall be as shown on Drawings, required by Code and/or specified in this Section.
- B. Related Sections
 - 1. 260519 - Low Voltage Electrical Power Conductors and Cables
 - 2. 260526 - Grounding and Bonding for Electrical Systems
 - 3. 260529 - Hangers and Supports for Electrical Systems

1.2 REFERENCES

- A. American National Standards Institute/Underwriters Laboratory
 - 1. ANSI C80.1 – Electrical Rigid Steel Conduit
 - 2. ANSI C80.3 – Steel Electrical Metallic Tubing
 - 3. ANSI C80.5 – Electrical Rigid Aluminum Conduit
 - 4. ANSI C80.6 – Electrical Intermediate Metal Conduit
 - 5. ANSI/UL 1 – Flexible Metal Conduit
 - 6. ANSI/UL 6 – Electrical Rigid Metal Conduit – Steel
 - 7. UL 6A – Standard for Electrical Rigid Metal Conduit – Aluminum and Stainless Steel
 - 8. UL 360 – Standard for Liquid Tight Flexible Steel Conduit
 - 9. UL 514A – Metallic Outlet Boxes
 - 10. UL 514B – Conduit, Tubing and Cable Fittings
 - 11. UL 651 – Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
 - 12. UL 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit
 - 13. ANSI/UL 651B – Standard for Continuous Length HDPE Conduit

14. ANSI/UL 797 – Electrical Metallic Tubing – Steel
15. ANSI/UL 1242 – Electrical Metal Intermediate Conduit – Steel
- B. National Electrical Manufacturers Association
 1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
 2. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
 3. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
 4. NEMA RN 1 – Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 5. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
 6. NEMA TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 7. NEMA WD 6 - Wiring Device Configurations.
- C. NECA (National Electrical Contractors Association) Standard of Installation.

1.3 SUBMITTALS

- A. Provide submittals for all products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, surface raceway finishes (custom factory pre-painting, color as selected by architect), and accessories.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.4 QUALITY ASSURANCE

- A. Raceways and boxes shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials and be in conformity with applicable standards and UL listings.
- B. Surface raceways shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and bear the UL label.
- C. Pull and junction boxes 50 cubic inches and smaller shall conform to specifications for outlet boxes.

- D. Pull and junction boxes larger than 50 cubic inches shall conform to U.L. Standard 50, Cabinets and Boxes.
- E. Perform Work in accordance with NECA Standard of Installation.
- F. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Conduit types specifically approved for use on this project shall be of the following types only:
 - 1. Galvanized rigid metal conduit - GRC or RMC.
 - 2. Intermediate metal conduit - IMC.
 - 3. Rigid copper-free aluminum conduit.
 - 4. Electrical metallic tubing - EMT.
 - 5. Polyvinyl chloride conduit - PVC: May be Schedule 40 or Schedule 80, except where Schedule 80 is specifically noted or specified.
 - 6. Flexible metal (steel) conduit - FMC or flex: In short lengths as specifically permitted.
 - 7. Liquid-tight flexible steel conduit - LFMC: In short lengths as specifically permitted.
 - 8. Extreme temperature liquid-tight flexible steel conduit - AT: Shall have temperature rating of -67 ° F to +220 ° F, Liqueflex "ATLA", or as approved.
 - 9. MC Cable, as specifically allowed in Section 260519 - Low Voltage Electrical Power Conductors and Cables
 - 10. Types specifically identified on the Drawings or in the Specifications
 - 11. Other products not specifically approved such as ENT, etc., are not allowed.

2.2 FIRE ALARM CONDUIT

- A. EMT conduit or MC cable utilized for fire alarm system wiring shall be factory pre-painted with a bright red topcoat, Allied Fire Alarm Red or as approved. Other conduit types utilized for fire alarm system wiring shall be identified with red paint or red tape wrapped a minimum of 4 times around the conduit every 10 feet and at each fire alarm system junction box.

2.3 CONDUIT FITTINGS

- A. Fittings utilized with rigid steel, IMC, and aluminum shall be galvanized steel or iron or copper-free aluminum and shall be threaded. Conduit bushings shall be provided and shall be of the insulated types. Where grounding bushings are required, provide insulated grounding bushings with integral pressure type ground lugs, Thomas & Betts “Blackjack”, or as approved.
- B. Couplings and connectors for EMT shall be made of steel or malleable iron. Die-cast products shall not be used. Connectors shall have insulated throats. Connectors and couplings shall be setscrew or compression type. Fittings for flexible metal conduit shall be steel or malleable iron only. All throats shall be insulated.
- C. Fittings for liquid-tight flexible conduit shall be steel or malleable iron, of a type incorporating a threaded grounding cone, nylon or plastic compression ring, and a tightening gland, providing a low resistance ground connection. All throats shall be insulated.

2.4 CONDUIT WITH INNERDUCTS

- A. Provide innerducts in conduits, cable trays and underground ductbanks of the type, size and quantity shown on the Drawings or as specified.
- B. Innerducts shall be 1-1/4 inch flexible ducts or as specifically shown on the Drawings. Standard color shall be orange unless otherwise noted.
 - 1. Interior locations:
 - a. Innerducts shall extend to the racks or equipment cabinet unbroken via conduit or cable tray, and terminate at the top of the rack, unless otherwise noted.
 - b. In building interior locations, provide plenum rated Carlon or as approved.
 - 2. Exterior locations:
 - a. In outdoor underground conduits, provide Carlon Corrugated HDPE, or as approved.
- C. Innerducts shall be field installable. Install all innerducts within a conduit at once, without kinking or crushing.

2.5 SURFACE METAL RACEWAY

- A. The Basis of Design is equipment from Wiremold, Hubbell or Mono-Systems, to set a standard for quality and style.
- B. Large multi-circuit raceways shall be sheet metal channel 4 3/4 inches wide, and fitted cover, suitable for use as surface metal raceway, Wiremold Series **4000**, or as approved.
- C. Small surface metal raceway for individual circuit runs shall be one piece surface metal raceway of the appropriate dimensions for the conductors, Wiremold Series 500/700, or as approved.

- D. Finish: Large raceways shall be factory pre-painted a custom color as selected by the Architect. Small raceways shall be furnished with factory ivory color finish and field painted to match adjacent surfaces, unless otherwise noted on the Drawings.
- E. Large raceways shall have factory pre-punched base channel mounting fastener holes. Provide suitable backing for mounting attachment, hollow wall anchors shall not be used.
- F. Provide manufacturer's standard Fittings, Boxes, and Extension Rings:
 - 1. Wall box connectors shall be concealed entry type.
- G. Uses Permitted
 - 1. Surface metal raceway shall only be used where specifically shown on the Drawings. Concealed conduit shall be used in all other locations.

2.6 MULTI-OUTLET ASSEMBLY

- A. Divided multi-outlet assemblies shall be sheet metal channel 4 3/4 inches wide, 1 3/4 inches deep with metal divider to separate power and communications wiring compartments and fitted cover, suitable for use as surface metal raceway, Wiremold Series 4000, or as approved. Mounting fastener holes shall be factory pre-punched.
- B. Single channel multi-outlet assemblies shall be sheet metal channel 2 3/4 inches wide, 1 17/32 inches deep with fitted cover, suitable for use as surface metal raceway, Wiremold Series 3000, or as approved. Mounting fastener holes shall be factory pre-punched.
- C. Device fittings shall be suitable to accept a single or duplex standard electrical outlet or multi-telecommunication jack as specified in other Sections, Wiremold 4047, or as approved.
- D. Entrance fittings shall accept concealed conductor entry from the back via a flush outlet box in the wall. Entrance fitting cross section shall be identical to the sheet metal channel and shall accept the same fitted cover. Entrance fitting openings shall be factory pre-punched.
- E. Finish: Multi-outlet assemblies shall be factory pre-painted a standard color as selected by the Architect.
- F. Base channel mounting fastener holes shall be factory pre-punched in raceways. Provide suitable backing for mounting attachment, hollow wall anchors are not allowed.
- G. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors.

2.7 WIREWAY

- A. Unless otherwise noted on the Drawings, surface wireway in exposed or concealed locations shall be sheet metal channel suitable for use as a wiring trough, with hinged or screw cover, sized in accordance with the NFPA 70. Wireway shall be Square D Class 5100, 5120, 5140, as appropriate for the environment, or as approved.

- B. Wireway shall be of the NEMA Type (general purpose, oil-tight, dust-tight, rain-tight, etc.) appropriate for the environment where installed.
- C. Wireway shall be furnished without factory pre-punched concentric or eccentric conduit knockouts. Knockouts shall be field punched as required for the conduits installed
- D. Finish shall be ANSI-49 gray epoxy paint finish applied by cathodic electrodeposition over a corrosion resistant phosphate preparation.

2.8 CAST BOXES

- A. Cast boxes with threaded hubs, external mounting brackets or holes, and gasketed covers shall be used in the following locations:
 - 1. Exterior locations.
 - 2. Wet or damp locations.
 - 3. Exposed interior locations below 48 inch above floor where subject to damage.
 - 4. Where shown on Drawings.

2.9 STEEL BOXES

- A. Galvanized pressed steel boxes may be used wherever they are permitted by code, except in areas indicated in the preceding paragraph.
- B. Flush mounted, pressed steel boxes shall be equipped with external mounting brackets for attachment to framing members with screws or nails.
- C. Ceiling boxes and wall boxes for bracket lights shall be not less than 4 inch in diameter by 1 ¼ inch deep and shall have 3/8 inch malleable iron fixture studs if required.
- D. Grounding Screw: All stamped steel boxes shall have a drilled and tapped hole in the back of the box for a grounding screw.
- E. Accessories: Box covers, extension rings, bases, hanger bars, etc., for use in connection with the installation, shall be approved for use in the various applications.

2.10 TELECOMMUNICATION OUTLET BOXES

- A. Boxes for telecommunication outlets shall be a minimum of 4 inches square by 2 1/8 inches deep.
- B. Device rings for telecommunication outlets shall be single-gang, minimum 5/8 inches deep, to provide a minimum internal finished depth of 2 3/4 inches.

2.11 FLOOR BOXES

- A. Floor boxes installed in rated floor assemblies shall meet the following:
 - 1. Surface mounted, supplied through floor.
 - 2. UL listed for fire resistance.
 - 3. Dual service, power and signal, with two duplex outlets barrier, two bushed openings, and all accessories.
 - 4. Brushed aluminum finish.
 - 5. Equipped with $\frac{3}{4}$ inch power conduit and 1 inch signal conduit.
 - 6. Square D "Fire-Gard" or approved equal.
 - 7. UL listed for scrub water exclusion per UL514A.

2.12 ACCESS FLOOR MODULES

- A. Access Floor Modules (AFMs) shall provide a fully flush appearance whether in use or not. Boxes in use shall have a hinged slot for the egress of cables from outlets to user equipment.
- B. AFMs shall consist of a floor insert with high capacity power, data and communications compartments.
- C. Box tops shall be Polymide, and shall include carpet/tile floor flange, hinged plate and retractable exit. Color selection shall include charcoal gray, dark brown and medium beige, minimum (color selection by the Contracting Agency through the submittal process).
- D. AFMs shall be equipped with all wiring devices and data/communications outlets as shown on the Drawings. Provide all accessories.
- E. AFMs shall be UL listed for scrub water exclusion per UL514A.
- F. AFMs shall be Steel City AFM-6 Access Floor Module capable of up to four duplex receptacles with data and communications.
- G. Materials
 - 1. Main box shall be made of 14 gage cold rolled steel, .070 inch minimum thickness, conforming to ASTM A366.
 - 2. Device panels shall be made of 16 gage cold rolled steel, .056 inch minimum thickness, conforming to ASTM A366.
 - 3. Hinged outer cover shall be reinforced with a $\frac{5}{32}$ " steel plate.
 - 4. Steel components to have an electrogalvanized zinc finish conforming to ASTM A386. Sheet metal steel fabrications shall be made of U.L. approved component G-90-U material.

5. Nonmetallic cover components shall be nylon, U.L. recognized component QMFZ2.

H. General Design

1. Shall provide concealed service access to power and communications outlets in a raised floor installation.
2. Shall deliver power and telephone/data cable without interference from electric power delivery.
3. The following sizes shall be provided:
 - a. AFM-6: 7 15/16" x 10" x 4" deep. Provides a minimum interior capacity of 225 cubic inches. Accepts up to 6 duplex receptacles.
4. Shall accept floor covering material as required.
5. Shall be self-leveling when installed.
6. Cover, when closed, shall protect exiting cables and cords from abuse and abrasion by retractable cable exits. Cover shall install flush with floor and be 180° reversible.
7. Carpet edge shall be protected from fraying by a carpet trim ring of a matching color.
8. AFMs shall accept conduit sizes as required on the plans.
9. Shall be listed by Underwriters' Laboratories

2.13 FLOOR BOXES

- A. Floor boxes shall provide a fully flush appearance whether in use or not. Boxes in use shall have a hinged slot for the egress of cables from outlets to user equipment.
- B. Boxes shall consist of a base preset for installation in concrete, and a floor insert with high capacity power, data and communications compartments. Preset castings shall be threaded to accept 1-1/4 inch conduit on one side and 3/4 inch conduit on the other.
- C. Box tops shall be Polymide, and shall include carpet/tile floor flange, hinged plate and retractable exit. Color selection shall include charcoal gray, dark brown and medium beige, minimum (color selection by the Contracting Agency through the submittal process).
- D. Boxes shall be equipped with all wiring devices and data/communications outlets as shown on the Drawings. Provide all accessories.
- E. All floor boxes shall be UL listed for scrub water exclusion per UL514A.
- F. Floor boxes shall be Steel City GAB Series AFM Pre-set Floor Box or approved equal. Provide Steel City AFM-6 insert capable of up to four duplex receptacles with data and communications.

2.14 FIRE RATED POKE THROUGHHS

- A. Fire rated poke throughs shall provide power and telecommunications service to floor mounted service pedestals via a through floor fitting that installs in a two inch hole.
- B. The unit shall incorporate individual EMT tubes for power and telecommunications. Power tube shall be ½ inch diameter EMT and telecommunications tube shall be ¾ inch EMT. Unit shall be UL Listed to accommodate up to ten #12 AWG type THHN wires and up to two 25 pair telecommunication cables. The total allowable copper cross-sectional area shall be no less than 11 square inches.
- C. The through floor fitting shall accept 2, 4 and 8 gang service pedestals that are partitioned to permit both power and telecommunications services.
- D. Fittings shall be UL classified for fire resistance 1-4 hour rated reinforced concrete floors and 1-3 hour rated floors employing steel form units.
- E. Service pedestals shall be equipped with all wiring devices and data/communications outlets as shown on the Drawings. Provide all accessories.
- F. Units shall be Hubbell 2 inch diameter fire rated poke throughs with gray service pedestals (2 gang, 4 gang or 8 gang as noted on the Drawings).

2.15 INDOOR PULL AND JUNCTION BOXES

- A. Indoor pull and junction boxes shall conform to Article 314 of the NEC and the following requirements:
 - 1. Sheet metal boxes are approved for use in all dry, interior, nonhazardous locations.
 - 2. Boxes installed in wet locations shall be NEMA 3R , unless otherwise noted.
 - 3. Furnish such boxes, whether shown or not, in order to conform to requirements for maximum pulling length and maximum number of bends allowed.
 - 4. Special boxes, as noted on the Drawings, shall be installed in areas of specific service and/or hazards.
- B. Junction box extension rings will not be accepted on new boxes. Appropriate size boxes shall be used for each application.

2.16 TELECOMMUNICATION SYSTEM PULL BOXES

- A. Telecommunication system Pull Boxes shall also conform to ANSI/EIA/TIA 569-A and the BICSI Telecommunications Distribution Methods (TDM) Manual.
- B. Dimensions:
 - 1. Pull boxes for straight through pulls shall have minimum interior dimensions in accordance with the following Table:

Maximum Trade Size Conduit	Size of Box			For Each Additional Conduit Increase Width
	Width (inches)	Length (inches)	Depth (inches)	
1 Inch	4	16	3	2 inches
1 1/4 Inch	6	20	3	3 inches
1 1/2 Inch	8	27	4	4 inches
2 Inch	8	36	4	5 inches
2 1/2 Inch	10	42	5	6 inches
3 Inch	12	48	5	6 inches
3 1/2 Inch	12	54	6	6 inches
4 Inch	15	60	8	8 inches

2.17 TELECOMMUNICATION SYSTEM SPLICE BOXES

- A. Unless otherwise specified or noted on the Drawings, splice boxes shall not be used in interior horizontal pathway conduits or interior backbone pathway conduits.
- B. Where required in a building service entrance or campus backbone pathway system, splice boxes shall be provided in accordance with the requirements of ANSI/EIA/TIA-569-A - Commercial Building Standard for Telecommunications Pathways and Spaces and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual.

2.18 UNDERGROUND PULL AND JUNCTION BOXES

- A. Boxes set in ground shall be either precast concrete or cast iron. Covers shall be galvanized steel or cast iron, and shall be bonded to the grounding system with a stranded grounding conductor secured with a grounding lug. Provide sufficient slack to allow removal of the cover and normal working access.
- B. Underground concrete pull boxes installed in traffic areas shall be constructed to withstand AASHTO HS-20 wheel loading.

2.19 OUTDOOR ABOVE-GROUND PULL AND JUNCTION BOXES

- A. Boxes exposed to rain or installed in wet locations shall be NEMA 3R unless otherwise noted.
- B. Outdoor pull and junction boxes and conduit bodies for use with galvanized conduits shall be made of galvanized ferrous metal or cast aluminum, with integral threaded hubs or Myers-type weathertight hubs of matching composition and finish.
- C. Furnish such boxes, whether shown or not, in order to conform to requirements for maximum pulling length and maximum number of bends allowed.

PART 3 - EXECUTION

3.1 CONDUIT USES PERMITTED

- A. Conduits shall be of the sizes shown on the Drawings or as required by the NEC, whichever is larger. Base sizes on using type XHHW for wire sizes #6 and smaller and type THHN/THWN wire for wire sizes #4 and larger. Unless otherwise noted, conduits installed in the following locations shall be of the types specifically identified only:
 - 1. Underground or encased in concrete - rigid steel, PVC-40 or IMC.
 - 2. Outdoors aboveground or damp locations - RMC, IMC or extreme temperature liquid-tight flexible steel conduit (where required).
 - 3. Dry indoor locations, concealed or exposed - RMC, rigid aluminum, EMT (where not susceptible to physical damage), flexible conduit where necessary, or IMC.
 - 4. Indoor locations, exposed, where susceptible to physical damage - RMC or IMC.
 - 5. Motor and equipment flexible connections - LFMC or FMC (when installed in plenum spaces).

3.2 RACEWAY INSTALLATION METHODS - GENERAL

- A. Concealed raceways: In occupied areas, conduit and raceways shall be concealed unless specifically noted otherwise. In service spaces (mechanical equipment rooms, electrical rooms, storage closets, etc.), approved raceways may be surface-mounted for connection to equipment in exposed surface mounted locations and in exterior locations as noted on the Drawings.
- B. Concealed raceways shall be routed as directly as possible with a minimum of bends. Concealed raceways above lay-in ceilings shall be installed a minimum of 12 inches above the ceiling grid.
- C. Exposed Raceways: Where allowed by this Specification or specifically noted on the Drawings, raceways may be mounted on the surface of walls, ceilings and other surfaces. Exposed raceways shall comply with the following:
 - 1. Exposed raceways shall be run parallel or perpendicular to building lines and bent symmetrically or made up with standard elbows or fittings.
 - 2. Surface-mounted conduit, junction boxes, pull boxes, outlet boxes, etc. installed in finished areas shall be painted to match the surrounding surfaces.
 - 3. Connectors and fittings for raceways and conduits installed on the surface in exterior locations shall be suitable for and Listed for use in a wet location.
 - 4. Conduits installed in exterior locations shall be painted to match the exterior finish of the building surface to which they are attached. This shall include conduits attached via racks and stand-off brackets, or attached directly to the surface.

- D. There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with this Section.
- E. Conduit and tubing shall be cut square and reamed smooth at the ends and all joints made tight. Conduit threads shall be lubricated with an approved thread lubricant.
- F. Raceway for power wiring shall not be installed in the floor slab beneath telecommunication rooms.
- G. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet box by means of a locknut on the outside and a locknut/bushing on the inside, or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter. Connections shall be made wrench tight. Locknuts shall be the bonding type with sharp edges and shall be installed in a manner that will assure a locking installation. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into threaded connections. Conduit runs shall be protected from the entrance of foreign material prior to the installation of conductors.
- H. Conduit or tubing deformed or crushed in any way shall not be installed. Conduit shall be bent only with approved bender (hydraulic or hickey). Bending machines shall be used to make field bends in conduit of 1-1/4 inch size and larger. Torches shall not be used in making conduit bends.
- I. Raceways shall be spaced at least 6 inches from parallel runs of heating system pipes, flues, other high temperature piping systems, and other heat sources. This basic spacing shall be increased if necessary to ensure that raceways experience no significant temperature rise from external sources. Raceways shall not be embedded in any spray applied insulation, fireproofing, or other materials that would restrict heat dissipation.
- J. Raceways for Audio/Video systems shall be spaced a minimum of 24 inches from parallel runs of conduits and wiring of power, lighting, and Class 1 signaling. Maintain at least 48 inches of separation from dimmed lighting circuits. Where runs are run parallel for less than 50 feet the required spacing may be halved (12 inches, or 24 inches from dimmed lighting circuits). Where runs are adjacent for less than 6 feet, or where conduits cross at right angles, separations of 2 inches may be used.
- K. Pull wires shall be provided in spare and unused conduits. (Nylon "jet-line" or as approved.)
- L. Conduits stubbed up out of floor and terminating inside of an enclosure shall have insulating grounding bushings installed.
- M. Raceways penetrating vapor barriers or traversing from warm to cold areas shall be sealed on the inside with a non-hardening duct sealing compound to prevent the accumulation of moisture, and shall be taped airtight to the vapor barrier on the outside. Refer to Section 260000 for additional requirements and limitations regarding penetration of vapor barriers.
- N. Raceways (particularly PVC) shall be provided with expansion joints where necessary to allow for thermal expansion and contraction. Set initial opening of expansion joints per manufacturer's instructions, to suit the ambient temperature at the time of installation.

- O. Provide flexible conduit connection at seismic joints to allow for displacement of conduit in all three axes. Provide appropriate lengths of flexible conduits at seismic joints and appropriate amounts of slack in conduit to allow movement of conduit/cabling in accordance with the design of the seismic joint. Slack shall be maintained in conduit after cabling is installed. Minimum lengths of flexible conduit and minimum amount of slack for various size conduits shall be as follows:
 - 1. 2 inch and greater: 4 foot length, 4-6 inches slack.
 - 2. 1-1/2 inch and smaller: 2 foot length, 3 inches slack.
- P. Flexible metal conduit with supplemental ground jumper shall be used for connection to vibrating equipment, or where installation conditions warrant its use with express permission. Flexible conduit shall not penetrate walls. Liquid-tight flexible conduit with supplemental ground jumper shall be used for motor and transformer connections (except utilize flexible metal conduit in plenum spaces). The ground jumper in flexible conduits shall be routed within the conduit.
- Q. Length of flexible conduit shall not exceed 36 inches, except for lighting fixture whips and where specifically noted. Fixture whips shall not exceed 72 inches. Flexible conduit shall not penetrate walls or vapor barrier retarder/barrier.
- R. Electrical raceways may penetrate roofing membranes only where absolutely necessary. Submit intended locations to Contracting Agency for approval prior to installation. Such penetrations shall be flashed and sealed as required for mechanical piping penetrations of roof. Where practical, conduits stubbed up to roof mounted equipment shall be routed within the equipment curb supporting the equipment.

3.3 RACEWAY INSTALLATION METHODS – TELECOMMUNICATIONS SYSTEMS

- A. Installation methods for telecommunication system conduits shall comply with Installation Methods – General, above, unless superseded by more stringent requirements of this section.
- B. Telecommunications conduits shall comply with the requirements of TIA/EIA-569-A and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual. Note that some of these requirements are more stringent than the requirements of the National Electrical Code.
- C. There shall be no more than two 90-degree bends between pull points in telecommunications conduit. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with this Section. If it is not practical to install a pull box in the run due to field conditions, the conduit size shall be increased to the next trade size for each additional 90-degree bend. Offsets shall be considered as equivalent to a 90-degree bend.
- D. Inside radius of conduit bends shall be at least 6 times the internal diameter of the conduit for sizes up to 2 inch trade size; 10 times the internal diameter of the conduit for sizes larger than 2 inch trade size. Where bending machine shoes are not available with the required bending radius for a one-shot field bend, factory bent, large radius 90-degree elbows shall be provided. Conduits of all sizes for use as optical fiber raceways shall have a minimum inside bend radius of 10 times the internal diameter of the conduit.

- E. Conduits stubbed to cable trays shall be terminated within a maximum horizontal distance of 4 inches from the tray and in a vertical zone between 1 to 6 inches above tray. Conduits shall be supported from structure within a maximum horizontal distance of 12 inches from the tray. Conduits shall be provided with a grounding bushing and shall be bonded to the cable tray with a minimum 12 AWG copper conductor.
- F. Use of flexible conduit for telecommunications shall be kept to a minimum and shall be at the discretion of the Contracting Agency. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used (see Conduit Sizes).
- G. Conduits entering the telecommunications room or equipment room through the floor shall be terminated 4 inches above finished floor. Conduits entering the telecommunications room or equipment room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate more than 12 inches above the cable pathway support or distribution frame.
- H. Conduit sleeves connecting vertically “stacked” telecommunications rooms shall be terminated 4 inches above finished floor. Conduits and cutout openings between floors shall be sealed with firestopping material that is reusable, to accommodate additions and deletions, moves and changes in the cabling system.
- I. Layout of conduits shall give consideration to nearby sources of electromagnetic energy such as electrical power wiring, large electric motors and generators, induction heaters, arc welders, variable frequency drives, etc. Maintain the greatest separation practicable between telecommunication raceways and sources of electromagnetic interference (EMI). A minimum of 5 inches of separation shall be maintained between telecommunication raceways and fluorescent lighting ballasts.
- J. Pull wires shall be provided in spare and unused conduits. (Nylon “jet-line” or as approved.)
- K. Maintain minimum separation from $\leq 480V$ power wiring in accordance with the following table:

Condition	Minimum Separation Distance		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to open non-metal telecommunications pathways	5 inches	12 inches	24 inches
Unshielded power lines or electrical equipment in proximity to a grounded metal telecommunications conduit pathway	2.5 inches	6 inches	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal telecommunications conduit pathway	--	3 inches	6 inches

3.4 CONDUIT SIZES – GENERAL

- A. Minimum sizes for rigid steel, IMC, FRE, rigid aluminum and PVC-40 conduits shall be ¾ inch.
- B. Minimum size for EMT shall be ½ inch.
- C. Minimum size for flexible conduits shall be ½ inch , except fixture whips may be 3/8 inch as allowed by the NEC.
- D. Maximum size for EMT shall be 4 inch.

3.5 CONDUIT SIZES – TELECOMMUNICATIONS SYSTEMS

- A. Minimum size for telecommunications building service entrance conduit shall be 4inch.
- B. Minimum size for conduit runs to outlets is 1 inch.
- C. Unless indicated otherwise, individual conduit homeruns shall serve no more than two telecommunications outlet.

3.6 STRUCTURAL COORDINATION

- A. Layout conduits in slabs to avoid compromising structural integrity. Obtain approval from Structural Engineer for maximum conduit sizes, quantities, arrangement, and placement in structural slabs.
- B. Structural members shall not be cut, drilled, or notched for raceways or other electrical features unless specifically accepted by the Contracting Agency.

- C. Underfloor raceways for slab-on-grade construction shall be embedded in the fill under the slab, not in the slab itself. Where raceways are required or permitted to be embedded in concrete, the thickness of concrete on all sides of each raceway shall not be less than 2 inches.

3.7 SURFACE RACEWAY INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- C. Provide outlets in locations shown or according to spacing specified on the Drawings. Where spacing is specified, the maximum distance from each end of the raceway to the first outlet shall not exceed one-half of the specified spacing distance. Mounting elevations shall be as noted on the Drawings or as shown on the Architectural Elevations. If a conflict exists, the elevation shown on the Architectural Elevations shall take precedence.
- D. Provide field paint touch-up with factory furnished paint to match factory pre-painted finish, for all chips, scraps, scratches, fittings and unpainted sections of the surface raceways and multi-outlet assemblies, after installation of all devices and covers are complete.
- E. Provide appropriate separate device finish plates for outlets and telecommunication jacks as specified in other Sections.
- F. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- G. Close ends of wireway and unused conduit openings.
- H. Ground and bond raceways, multi-outlet assemblies and wireways under provisions of Section 260526 – Grounding and Bonding for Electrical Systems.

3.8 OUTLET BOX INSTALLATION

- A. Outlet boxes shall be securely fastened in position and supported independently of the conduit system.
- B. Outlet boxes located in suspended ceiling system shall be fastened to ceiling "t-bar" system with bar-hanger rods manufactured for the purpose, or from hanger rods with solid supports from structure above. "T-bar" hanger rods shall be clipped to cross-members supported by the main ceiling support members. Outlet boxes supported from the suspended ceiling system shall be provided with one safety wire attached to the box or box support clip, or two safety wires attached to the bar hanger.
- C. Boxes shall be installed true to the building lines and at equal heights in conformity with mounting heights specified in other sections of the specification.
- D. Provide the best suitable box for each outlet requirement. Extension rings shall not be used on new construction except where needed to bring an outlet box out to 1/8 inch of the finished wall or ceiling line.

- E. Boxes shall have only the holes necessary to accommodate the conduits at point of installation. All boxes shall have lugs or ears to secure covers.
- F. Boxes shall be rigidly secured in position. Recessed boxes shall be so set that the front edge of the box shall be flush with the finished wall or ceiling line, or not more than 1/8 inch back of same. This requirement is more stringent than NEC requirements.
- G. Boxes shall be accessible.
- H. Provide boxes for each application that will not violate the fire rating of the wall, floor or ceiling assembly in which the box is installed.
- I. Do not place order for floor boxes without ensuring that the Contracting Agency has positively approved submittals for the specific cover types/styles colors necessary for all applications and locations.
- J. Recessed boxes shall not be placed back-to-back in adjacent rooms. They shall be offset at least 12 inches, or greater as required by codes and standards applicable to the specific construction.
- K. Boxes (electrical boxes, outlet boxes and telecommunication boxes, etc) penetrating fire rated walls, walls with vapor retarder/barriers, wall types that extend to structure or wall types that contain batts shall be sealed airtight with approved Firestop Putty Pads to reduce sound transmission, reduce air transmission and increase fire resistance. Mold putty pads around electrical junction boxes and conduits to form an airtight seal in accordance with manufacturer's installation instructions.

3.9 JUNCTION BOX AND PULL BOX INSTALLATION

- A. Junction and pull boxes shall be installed so that covers are readily accessible and adequate working clearance is maintained after completion of the installation.
- B. Select boxes properly sized per NEC for power and lighting applications.

3.10 TELECOMMUNICATIONS SYSTEM PULL BOXES

- A. Where a pull box is required in a 1 inch conduit run, outlet boxes as specified in this Section may be used. Where a pull box is required in a conduit run 1 1/4 inch or larger, or where required for multiple raceways, the box shall be sized in accordance with the Table in this Section.
- B. Pull boxes shall be located in straight-through sections of horizontal cabling pathways (conduits). Pull boxes shall not be used for angle pulls or to accomplish changes in direction of the pathway.
- C. Multiple raceways connecting to telecommunications system pull boxes shall penetrate box walls such that they are distributed evenly along the Box wall.

3.11 TELECOMMUNICATIONS SYSTEM JUNCTION BOXES

- A. Unless otherwise specified or noted on the Drawings, junction boxes shall not be used in interior horizontal pathway conduits or interior backbone pathway conduits. Where allowed, junction boxes shall be located in a readily accessible location. Junction boxes shall not be located in above ceiling spaces.
- B. Junction boxes for telecommunication shall be hinged covered cabinets, sized in accordance with the requirements of ANSI/EIA/TIA-569-A.
- C. Junction cabinets shall have a fire-treated plywood backboard suitable for mounting punch-down style terminal blocks, in accordance with 272010 - Telecom Distribution System.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide identification of on all equipment, raceways, boxes and conductors.
- B. Section includes:
 - 1. Nameplates
 - 2. Labels
 - 3. Wire markers
 - 4. Conduit markers
 - 5. Miscellaneous Electrical Identification
- C. Related Sections: Divisions 26, 27 and 28 Sections.

1.2 SUBMITTALS

- A. Division 1 and Section 260000 - Electrical General Requirements.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Electrical Distribution Equipment Labels and Nameplates
 - 1. Name equipment in accordance with Contract Documents.
 - 2. Nameplates shall be laminated plastic, 0.125 inch thick, with matte finish and square corners. Minimum lettering size as noted elsewhere in this section.
 - a. Label and Nameplate Colors:
 - 1). Normal Equipment: White letters on a black background.

- 2). Emergency Equipment: White letters on a red background.
 - 3). Standby Equipment: Black letters on a yellow background.
- b. Securely attach labels with threaded fasteners or pop-rivets. Adhesive attachment not acceptable.
 - c. Temporary markings not permitted on equipment. Repaint trims, housings, etc., where markings cannot be readily removed. Refinish defaced finishes.
3. Include item designation and branch circuit designation (panel and circuit number) on disconnects, starters, equipment and device nameplates, e.g., "FAN No. 4, Circuit LA-30").

2.2 WIRE AND CABLE MARKERS

- A. Wire and Cable Markers: Wrap on labels, cloth tape type wire markers or tubing type for all phase, neutral and ground conductors.

2.3 LABELS

- A. Adhesive film label with clear protective overlay: Machine printed, in black, by thermal transfer process or equivalent. Minimum lettering size as noted elsewhere in this section. Overlay shall provide a weatherproof and UV resistant seal for label.

2.4 UNDERGROUND ELECTRICAL LINE PLASTIC LINE MARKER

- A. Minimum 4 inch wide plastic tape with metallic core with suitable legend describing buried electrical lines.

2.5 POWER ONE-LINE DIAGRAM

- A. Laminated, approved print of the "As-Built" power distribution system. Install in accordance with Part 3.

PART 3 - EXECUTION

3.1 NAMEPLATE INSTALLATION

- A. Install nameplate parallel to equipment lines.
- B. Mechanically fasten nameplates using threaded fasteners or pop rivets.
- C. Mechanical fasteners shall have no sharp edges or points which can damage conductors or injure personnel.
- D. Temporary markings are not permitted on equipment. Repaint trims, housings, etc., where markings cannot be readily removed. Refinish defaced finishes.

- E. No labeling abbreviations are permitted without prior approval.

3.2 BRANCH AND DISTRIBUTION PANELBOARD NAMEPLATES

- A. Nameplate shall contain the following information (minimum ½ inch height letters):
1. Line 1: Panel Name as noted on drawings and schedules.
 2. Line 2: Voltage and Phase.
 3. Line 3: Shall indicate if panelboard is "NORMAL" (black background), or "STANDBY" (yellow background) or "EMERGENCY" (red background).
 4. Line 4: Source from which panel is fed, "FED FROM: PANEL NH-031".
- B. Install a 2 inch x 4 inch nameplate on each branch panelboard where a building contains distribution systems of different voltages (minimum 1/8 inch height letters):

THIS BUILDING CONTAINS TWO WIRING SYSTEMS:				
	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>	<u>Neutral</u>
480Y/277V	Brown	Orange	Yellow	Gray
208Y/120V	Black	Red	Blue	White

3.3 NAMEPLATE LOCATIONS

- A. Provide 1 inch minimum height letters on following equipment:
1. Service disconnect(s) (red background).
 - a. Enclosures containing multiple service disconnects for utility power must clearly identify each switch as a service disconnect along with the load served.
 - b. Where the building has multiple electrical services at different locations, provide signage at each service that indicates the total number and location of all electrical service disconnects that control the electrical service to the building.
 - c. Where an on-site emergency power source is provided, a sign shall be placed at the service entrance(s) indicating the type and location of on-site emergency power sources.
- B. Provide 1/2 inch minimum height letters on following equipment:
1. Service equipment Fault Current: Provide signage in accordance with NEC indicating maximum available fault current and date of fault current calculation.
 2. Secondary feeder breakers in distribution equipment. Designation as required by load served.
 3. Special equipment housed in cabinets, as designated on plans, on outside of door.

4. Equipment housed in equipment cabinets, as designated on plans, on inside of cabinet door.
 5. Switchboards, motor control centers, transformers, as designated on plans, on outside of door or equipment.
 6. Emergency system equipment, boxes and enclosures, as designated on plans, on outside of equipment, boxes and enclosures.
 7. Control or low voltage system panels such as Fire Alarm, Security, Video Surveillance, etc., with the following information:
 - a. Line 1: Unique panel name as shown on the shop drawings.
 - b. Line 2: System description such as Fire Alarm, Security, etc.
 - c. Line 3: Panelboard and circuit number from which the panel is fed if applicable.
- C. Provide 1/4 inch minimum height letters on:
1. Disconnects, starters, VFDs and contactors:
 - a. Line 1: Load Served (Use nameplate designation for source).
 - b. Line 2: Panelboard and circuit number from which the device is fed.
 - c. Line 3: Voltage, Phase, fuse size or circuit breaker size.
 2. Lighting control relays, dimmer controls and remote lighting control equipment.
 3. Switches and receptacles where item controlled is not visible from the switch, or as noted on Drawings.
 4. External Power Sources: Provide 1/4 inch white letters on red background on all starters or controllers that receive power from an external source that is not de-energized by operating the associated disconnecting means.
 5. Designated electrical equipment.

3.4 RECEPTACLE AND LIGHT SWITCH DEVICE PLATES

- A. Provide 3/16 inch minimum height letters on receptacle and light switch device plates:
1. Provide clear adhesive label (black letter on clear background) indicating branch circuit designation (panel and circuit number) on receptacle and light switch device plates, e.g., "NPA-30"). Labels shall be printed not hand written.

3.5 TELECOMMUNICATION LABELING REQUIREMENTS.

- A. Provide machine printed labels for all telecommunication racks, cabinets, patch panels, cables, outlets, etc., in accordance with ANSI/TIA/EIA-606-B. Provide labeling nomenclature in accordance with information on the Drawings or Owner's labeling conventions. Submit labeling samples for all required applications.
- B. Machine Printed Label Requirements:

1. PC Compatible.
2. Can save and modify files.
3. Fully integrated with AutoCAD.
4. Editable Fonts and Sizes.
5. Rotate Text and Objects.
6. Vary Line Spacing.
7. Ability to import graphical images.
8. Capable for customization of layout.
9. Re-positional labels.

C. Basis of Design:

1. Brady Electrical/Datacomm Worldwide (latest version of LabelMark).
2. Cable Management Software International (latest version of docIT).
3. Approved alternate.

D. Labeling and color coding identification for this project shall conform to TIA/EIA-606-B for a Class 2 Administrative System.

3.6 LABEL LOCATIONS

A. Provide 3/16 inch minimum height letters on the following equipment:

1. Security System Device Labels:

- a. Provide label on each security field device, denoting device address. Affix label to device faceplate for ceiling-mounted devices or wall mounted devices above 8'-0" AFF. Affix label inside back box for exterior devices.

2. Fire Alarm Device Labels:

- a. Provide label on exterior surface of each initiating device denoting the unique device address corresponding to the text annunciator description. For detectors, the label shall be affixed to the base and not to the detector itself. For pull stations, the label shall be affixed to the top of the device and not to the vandal proof cover.
- b. Provide label on each remote test station indicating description and location of device being tested.
- c. Provide label on telecom conductors at each end denoting FACP lines for use with the digital alarm communicator transmitter (DACT).

3.7 DISTRIBUTION/BRANCH CIRCUIT PANELBOARD CIRCUIT LABELING

- A. Distribution Panels and Branch Circuit Panelboard Directories: Provide neatly typed schedule (odd numbered circuits on left side or top, even on right side or bottom) under plastic jacket or protective cover to protect the schedule from damage or dirt. Securely mount on inside face of panelboard door. Define briefly, but accurately, nature of connected load (i.e., Lighting Room 201, Receptacles Janitor Room 155, Etc.) as approved. Sequentially numbered schedules shall not be used.
- B. Use final approved room numbers from finished construction (not necessarily as indicated on the drawings).
- C. Provide numbering for terminals on terminal strips in the terminal enclosure that identifies the origin, function and destination of each conductor.
- D. Install wire marker for each conductor inside panelboards (phase, neutral and ground conductors). Locate label within 6 inches of termination. Labels shall be visible with panel dead front installed.
- E. Dedicated branch circuit(s) feeding fire alarm control unit(s) shall be identified as "FIRE ALARM CIRCUIT" in accordance with NFPA 72. The circuit disconnecting means shall be identified with red marking.

3.8 EMERGENCY SYSTEM IDENTIFICATION

- A. Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system by the following methods:
 - 1. All equipment, boxes and enclosures (including transfer switches, generators and power panels) for emergency circuits shall be permanently marked as a component of an emergency circuit or system.
 - 2. Where boxes or enclosures are not encountered, exposed cable or raceway shall be permanently marked to be identified as a component of an emergency circuit or system at intervals not to exceed 25 feet.
 - 3. Receptacles supplied from the emergency system shall have a distinctive color (red) and circuit identification on the receptacle cover plate as noted elsewhere in these specifications.

3.9 WIRE MARKER INSTALLATION

- A. Install wire marker for each conductor (phase, neutral and ground conductors) at panelboards, pull boxes, outlet and junction boxes, and each load connection. Locate label within 6 inches of termination in panelboards. Labels shall be visible with panel dead front installed.
- B. Wire markers are not required on conductors in a pull or junction box that contains only an individual branch circuit, however, source panel and circuit number shall be noted on pull or junction box cover as noted elsewhere in this section.

- C. Fire Alarm Circuits: Provide cable markers showing Notification Appliance Circuit (NAC) or Signaling Line Circuit (SLC) loop identification number at fire alarm junction boxes and pullboxes.
- D. Security System Cables: Install wire marker for each cable at cabinets, pull boxes, junction boxes, and each load connection. Wire ID number shall be as shown on security system shop drawings.
- E. Power Circuits: Panelboard name and branch circuit or feeder number.
- F. Control Circuits: Control wire number as indicated on schematic and/or shop drawings.
- G. Color Code:
 - 1. Color code phases, neutral, and ground per NEC requirements and Section 260519 – Wire and Cable.
 - 2. Color code all low voltage system wiring in accordance with applicable Sections.

3.10 TRANSFORMERS

- A. Nameplate shall contain the following information:
 - 1. Line 1: Transformer Name as noted on drawings and schedules.
 - 2. Line 2: KVA Rating/Primary/Secondary Voltage.
 - 3. Line 3: Source from which transformer is fed, “FED FROM: PANEL NHA”
 - 4. Line 4: Destination of transformer feed, “FEEDS: PANEL NPA.
- B. When the transformer disconnect is located in a remote location, the disconnecting means shall be labeled to reference the transformer location in accordance with NEC Article 450.

3.11 MISCELLANEOUS ELECTRICAL IDENTIFICATION

- A. Junction Boxes: Mark the circuit number(s) and panel source of wiring on all junction boxes with sheet steel covers. Mark with indelible black marker. On exposed junction boxes in finished areas mark on inside of cover.
- B. Conduits
 - 1. Mark all conduits entering or leaving panelboards with indelible black magic marker with the circuit numbers of the circuits contained inside.
 - 2. Fire Alarm System: Paint fire alarm conduits with a 6 inch band 10 feet on center with red paint where installed in concealed accessible location (or provide red conduit in accordance with Section 260519 – Low Voltage Electrical Power Conductors and Cables and Section 260533 – Raceways and Boxes for Electrical Systems. Where raceway is installed in exposed locations it shall be painted to match the adjacent surface.

3. Empty Conduits: Provide tags with typed description of purpose, and location of opposite end, wired to each end of conduits.
- C. Junction Boxes
1. Markings shall be made with indelible black marker.
 2. On exposed junction boxes in finished areas markings shall be on inside of cover.
 3. Mark the circuit numbers of wiring on all junction boxes with sheet steel covers.
 4. Mark all Special System junction boxes with sheet steel covers with appropriate system designation, e.g., "Intercom", "Clock", "Telecom", "Video Surveillance", etc. Fire Alarm System: Paint all fire alarm junction boxes inside and out with red paint where installed in concealed accessible location. Where installed in exposed locations paint boxes to match the adjacent surface.
- D. Label Service shunt trip switch "ELECTRICAL SERVICE DISCONNECT".
- E. Label Generator System shunt trip switch "GENERATOR ELECTRICAL DISCONNECT".
- F. One-Line Diagram: Mount behind protective cover (1/8-inch minimum thickness clear Plexiglas) in accessible location at main switchboard.
- G. Exterior underground power, control, signal and communications lines.
1. Install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches provide additional markers.
 2. Install markers for both direct buried and conduit encased conductors.
 3. Label each underground conductor with its circuit number or identification tag.
- H. Provide a label at the fire alarm control panel that identifies the panelboard and circuit number that supplies the control panel. Provide a red label adjacent to the circuit breaker inside the panelboard that clearly identifies the circuit breaker that feeds the control panel in accordance with NFPA requirements.

3.12 CODE REQUIRED MARKINGS AND WARNINGS:

- A. Provide all placards, markings and identification systems required by Code and/or the Contract Documents, such as (but not limited to):
1. Arc Flash.
 2. Series Rated Systems.
 3. Conductor insulation color identification.
 4. Special conductor identification and legends.

5. Multiple services placards.
6. Emergency systems markings.
7. Emergency source grounded circuit conductor connected to a grounding electrode at a location remote from the emergency source: Provide a sign at the grounding location identifying all emergency and normal sources connected at that location.
8. Warning messages shall include an appropriate plain language imperative command, such as "DANGER HIGH VOLTAGE - KEEP OUT".
9. Available Fault Current: Service equipment shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault calculation was performed and shall be of sufficient durability to withstand the environment involved.

END OF SECTION 260553

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SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes specific requirements, products, and methods of execution relating to lighting controls, approved for use on this project.
- B. Related Sections
 - 1. 260553 - Identification for Electrical Systems
 - 2. 262726 - Wiring Devices
 - 3. 265000 - Lighting Fixtures

1.2 SUMMARY

- A. Provide a Code Compliant Networked Lighting Control System as indicated on plans and outlined in this section.
- B. Control Devices under this section are shown diagrammatically on the drawings and additional Class 1 and/or Class 2 wiring may be required for a complete system. It shall be the responsibility of the contractor and system vendor to determine the quantity and type of cable/wiring required for the complete and proper operation of the system. System design is based upon intelligent controls and/or lighting fixtures interconnected with CAT5 cables.
- C. Provide material, labor and programming to provide a complete and properly working system that complies with listed sequences of operation.
- D. Proper product adjustment, testing, and training shall take place in compliance with this document as well as applicable energy codes and listed sequences of operation.

1.3 SUBMITTALS

- A. Provide Submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Shop Drawings/Submittals shall include but not limited to:
 - 1. Layouts of photocells, occupancy sensors and networked devices necessary for a complete working system.
 - 2. Wiring diagrams showing the connection of all system parts and necessary electrical provisions to accommodate the intent of the design.

3. Installation sheets with complete product information.
4. Manufacturer Start-up Instructions and requirements.
5. Manufacturer's warranty certificate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of controls design Manufacturer: nLight, Acuity Brands, One Lithonia Way, Conyers GA 30012, www.acuitycontrols.com

2.2 SYSTEM REQUIREMENTS

- A. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
- B. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
- C. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
- D. Lighting control zones shall consist of one or more intelligent lighting control components and be capable of stand-alone operation.
- E. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- F. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- G. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- H. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone "bus power supplies" shall not be required in all cases.
- I. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

- J. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- K. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- L. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
- M. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
- N. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or WiFi backbone.
- O. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.
 - 1. Auto-On / Auto-Off (via occupancy sensors)
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
 - 2. Manual-On / Auto-Off (also called Semi-Automatic)
 - a. Pushing a switch will turn lights on.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - 3. Manual-On to Auto-On/Auto-Off
 - a. Pushing a switch will turn lights on.
 - b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
 - 4. Auto-to-Override On
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.

- b. Zone lighting then goes into an override on state for a set amount of time, or until the next time event returns the lighting to an auto-off style of control.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
- 5. Manual-to-Override On
 - a. Pushing a switch will turn lights on.
 - b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
 - c. Sequence can be reset via scheduled (ex. daily each morning) events.
- 6. Auto On / Predictive Off
 - a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
 - b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
 - c. Pressing the switch will turn the lights off and a short “exit timer” begins. After the timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
- 7. Multi-Level Operation (multiple lighting levels per manual button press)
 - a. Operating mode designed specifically for bi-level applications.
 - b. Enables the user to cycle through up to four potential on/off/dim low/dim high lighting states using only a single button.
 - c. Eliminates user confusion as to which of two buttons controls which load.
 - d. Three different transition sequences are available in order to comply with energy codes or user preference).
 - e. Mode available as a setting on all devices that have single manual on/off switch (ex. nPODM, nPODM-DX, nWSX LV).
 - f. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to “step” in a sequence that achieves bi-level operation is present.
 - g. Depending on the sequence selected, every button push steps through relay/dimming states according to table below:

		State of load after each pushbutton press			
MLO Mode		1st Press	2nd Press	3rd Press	4th Press
2-State (Alternating)	Load A	On	Off	Off	-
	Load B	Off	On	Off	-
2-State (Both On, A First)	Load A	On	On	Off	-
	Load B	Off	On	Off	-
2-State (Both On, B First)	Load A	Off	On	Off	-
	Load B	On	On	Off	-
3-State	Load A	On	Off	On	Off
	Load B	Off	On	On	Off
A and B On ¹	Load A	On	Off	-	-
	Load B	On	Off	-	-
A On Only ¹	Load A	On	Off	-	-
	Load B	Off	Off	-	-
A and B On & Dim High ¹	Load A	High	Off	-	-
	Load B	High	Off	-	-
Dim Low / High	Load A	Low	High	Off	-
Dim Low / High	Load A	High	Low	Off	-

NOTE 1: Modes for use only when Auto-On state of Load A & B is different than first MLO state

- P. A taskbar style desktop application shall be available for personal lighting control.
- Q. An application that runs on “smart” handheld devices (such as an Apple® iPhone®) shall be available for personal lighting control.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

A. Device Plates and Device Colors

- Device color for wall mounted devices shall match device color for wiring devices. Refer to Section 262726 - Wiring Devices.
- Device color for ceiling mounted devices shall be white.
- Device plate type and color shall match device plate type and color for wiring devices. Refer to Section 262726 - Wiring Devices.

B. Control module (gateway)

- Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.

2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices (up to 128 per port).
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 750 devices to the management software, with reduced memory version capable of support up to 400 devices.
9. Device shall be capable of using a dedicated static or DHCP assigned IP address.
10. Network Control Gateway device shall be the following nLight model Series:

nEYC

C. Networked system occupancy sensors

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
6. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).

7. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
8. Sensors shall be available in multiple lens options which are customized for specific applications.
9. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
10. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
11. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
12. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
13. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
14. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
15. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
16. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
17. Wall switch sensors shall have optional features for photocell/daylight override, and low temperature/high humidity operation.
18. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
19. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.
20. Wall switch sensors shall be the following nLight model numbers, with device color and optional features as specified:
 - nWSX** (PIR, 1 Relay)
 - nWSX PDT** (Dual Tech, 1 Relay)
 - nWSX LV** (PIR, No Relay)
 - nWSX PDT LV** (Dual Tech, No Relay)
 - nWSX LV NL** (PIR w/ Night Light, No Relay)
 - nWSX PDT LV NL** (Dual Tech w/ Night Light, No Relay)

nWSX LV DX (PIR, No Relay, Raise/Lower Dim Ctrl)

nWSX PDT LV DX (Dual Tech, No Relay, Raise/Lower Dim Ctrl)

21. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
22. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
23. Embedded sensors shall have an optional photocell
24. Embedded sensors shall be the following nLight model number:
 - nES 7** (PIR, No Relay)
 - nES 7 ADCX** (PIR w/ Photocell, No Relay)
 - nES PDT 7** (Dual Technology, No Relay)
 - nES PDT 7 ADCX** (Dual Technology w/ Photocell, No Relay)
25. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
26. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
27. Sensors shall be the following nLight model numbers, with device options as specified:

Model # Series	Occupancy Poles	# of Relays	Lens Type	Detection Technology
nCM(B) 9	1	-	Standard	PIR
nCM(B) 9 2P	2	-	Standard	PIR
nCM 9 RJB	1	-	Standard	PIR
nCM 9 2P RJB	2	-	Standard	PIR
nCM(B) PDT 9	1	-	Standard	Dual
nCM(B) PDT 9 2P	2	-	Standard	Dual
nCM PDT 9 RJB	1	-	Standard	Dual
nCM PDT 9 2P RJB	2	-	Standard	Dual
nCM(B) 10	1	-	Extended	PIR
nCM(B) 10 2P	2	-	Extended	PIR
nCM 10 RJB	1	-	Extended	PIR
nCM 10 2P RJB	2	-	Extended	PIR

nCM(B) PDT 10	1	-	Extended	Dual
nCM(B) PDT 10 2P	2	-	Extended	Dual
nCM PDT 10 RJB	1	-	Extended	Dual
nCM PDT 10 2P RJB	2	-	Extended	Dual
nRM 9	1	-	Standard	PIR
nRM PDT 9	1	-	Standard	Dual
nRM 10	1	-	Extended	PIR
nRM PDT 10	1	-	Extended	Dual
nRM 6	1	-	High Bay	PIR
nRM 50	1	-	Aisle Way	PIR
nWV 16	1	-	Wide View	PIR
nWV PDT 16	1	-	Wide View	Dual
nHW13	1	-	Hallway	PIR
nCM(B) 6	1	-	High Bay	PIR
nCM 6 RJB	1	-	High Bay	PIR

D. Networked system daylight (photocell and/or dimming) sensors

1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Photocell and dimming sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
5. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
6. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
7. Sensor shall be the following nLight model numbers, with device options as specified:

- nCM(B) PC (RJB)** (on/off)
- nCM(B) PC DZ (RJB)** (on/off control, dual zone)
- nCM(B) ADCX (RJB)** (remote automatic dimming control photocell)
- nCM(B) ADCX DZ (RJB)** (remote automatic dimming control photocell, dual zone)
- nRM PC** (on/off)
- nRM PC DZ** (on/off, dual zone)
- nRM ADCX** (remote automatic dimming control photocell)
- nRM ADCX DZ** (remote automatic dimming control photocell, dual zone)

8. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
9. Embedded sensors shall be the following nLight model number:
 - nES ADCX** (Dimming Photocell)

E. Networked System Power (Relay) Packs

1. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
3. All devices shall have two RJ-45 ports.
4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
7. Power Packs and Power Supplies shall be available that are WiFi enabled.
8. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.

9. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
12. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
13. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
14. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
15. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
16. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.
17. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
 - nPP16** (Power Pack w/ 16A relay)
 - nPP16 D** (Power Pack w/ 16A relay and 0-10VDC dimming output)
 - nPP16 WIFI** (Power Pack w/ 16A relay, WIFI enabled)
 - nEPP5 D** (Power Pack w/ 5A relay and 0-10VDC dimming output)
 - nSP16** (Secondary Pack w/ 16A relay)
 - nPP16 ER** (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
 - nPP16 D ER** UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching/dimming emergency power circuits)
 - nSP5 PCD 2W** (Secondary Pack w/ 5A relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
 - nSP5 PCD 3W** (Secondary Pack w/ 5A relay and 3-wire line voltage fluorescent dimming output)
 - nSP5 PCD MLV** (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
 - nSP5 PCD ELV 120** (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
 - nSP5 2P LVR** (Louver/Damper Control Pack)
 - nSHADE** (Pulse On/Off Control Pack)
 - nPP20 PL** (Secondary Pack w/ 20A relay for general purpose receptacle load)

nPS 80 (Auxiliary Bus Power Supply)

nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)

nAR 40 (Low voltage auxiliary relay pack)

F. Networked System Relay & Dimming Panels

1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
2. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
3. Panel shall provide one 0-10VDC dimming output paired with each relay.
4. Panel shall power itself from an integrated 120/277 VAC supply.
5. Panel shall be capable of operating as either two networked devices or as one.
6. Panel shall supply current limited low voltage power to other networked devices connected via CAT-5.
7. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection.
8. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
 - nPANEL 4** (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
 - nPANEL 2 480** (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

G. Networked Auxiliary Input / Output (I/O) Devices

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
5. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.
7. Specific I/O devices shall sense state of low voltage outdoor photocells.

8. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).
10. Auxiliary Input/Output Devices shall be the following nLight model numbers:
 - nIO D** (I/O device with 0-10 dimming output)
 - nIO 1S** or **nIO RLX** (I/O device with contact closure or 0-10VDC dimming input)
 - nIO NLI** (Input device for detecting state of low voltage outdoor photocell; sold in **nIO PC KIT** only)
 - nIO X** (Interface device for communicating with RS-232 enabled AV Touch Screens)

H. Networked System Wall Switches & Dimmers

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
3. All devices shall have two RJ-45 ports.
4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
6. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
7. Devices with mechanical push-buttons shall be made available with custom button labeling
8. Devices with a single “on” button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
 - nPODM** (single on/off, push-buttons, LED user feedback)
 - nPODM DX** (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
 - nPODM 2P** (dual on/off, push-buttons, LED user feedback)
 - nPODM 2P DX** (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
 - nPODM 4P** (quad on/off, push-buttons, LED user feedback)

nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

I. Networked System Graphic Wall Station

1. Device shall have a 3.5" full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
3. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
4. Device shall enable user supplied .jpg screen saver image to be uploaded.
5. Device shall surface mount to single-gang switch box.
6. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
7. Device shall have a micro-USB style connector for local computer connectivity.
8. Device shall have two RJ-45 ports for communication
9. Device shall be the following nLight model number:

nPOD GFX

J. Networked System Scene Controllers

1. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
3. Device shall recess into single-gang switch box and fit a standard GFI opening.
4. Devices shall provide LED user feedback.
5. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
6. All devices shall have two RJ-45 ports.
7. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
8. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).

9. Device shall have LEDs indicating current selection.
10. Scene Selector device shall be the following nLight model number:

nPODM 2S (2 Scene, push-button)

nPODM 4S (4 Scene, push-button)

nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)

nPODM 2L (2 Adjustable Preset Levels, push-button, On/Off)

nPODM 2L AB (2 Scene, push-button, On/Off/High/Low)

nPODM 4L DX (4 Adjustable Preset Levels, push-button,
On/Off/Raise/Lower)

K. Communication Bridges

1. Device shall surface mount to a standard 4" x 4" square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.
5. Device shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
6. Communication Bridge devices shall be the following nLight model numbers:

nBRG 8 (8 Ports)

2.4 LIGHTING CONTROL PROFILES

- A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
- C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

- D. Specific device parameters (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
- E. All lighting control profiles shall be stored on the network control gateway device, with a system backup on the software's host server.
- F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.
- G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
- J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.5 MANAGEMENT SOFTWARE

- A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software
- B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).
- C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- D. A printable network inventory report shall be available via the software.
- E. A printable report detailing all system profiles shall be available via the software.
- F. Software shall require all users to login with a User Name and Password.
- G. Software shall provide at least three permission levels for users.
- H. All sensitive stored information and privileged communication by the software shall be encrypted.
- I. All device firmware and system software updates must be available for automatic download and installation via the internet.
- J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.6 START-UP & SUPPORT FEATURES

- A. To facilitate start-up, all devices daisy-chained together shall automatically be grouped together into a functional lighting control zone.
- B. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
- C. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
- D. All system devices shall be capable of being given user defined names.
- E. All devices within the network shall be able to have their firmware upgraded remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
- F. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

2.7 PREPARATION

- A. Prior to beginning rough-in for the automatic lighting controls a pre-installation meeting is mandatory for all parties involved in the lighting control system installation, including the System Installer, the manufacturer's Factory Authorized Representative and the Owner's Representative if desired. All parties shall review the automatic lighting control shop drawings, the manufacturer's installation instructions, applicable regulations and any site conditions pertinent to installation of the automatic lighting controls. Verify placement of sensors and installation criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with the manufacturer's instructions in the locations indicated on the Drawings. Proper judgment must be exercised in executing the installation so as to ensure proper operation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- B. Locate and aim occupancy sensors as required for complete and proper volumetric coverage within the range of coverage of controlled areas per the manufacturer's recommendations. Rooms shall have 90% minimum coverage to completely cover the controlled area. Coverage shall accommodate all occupancy habits of single or multiple occupants at any location within the room. The locations and quantities of sensors shown on the Drawings are diagrammatic and indicate only the minimum quantity and placement of sensors that are to be provided. Provide additional sensors if required to properly and completely cover the respective room.
- C. All occupancy sensors shall be installed in accordance with manufacturer's recommendations. All units shall be set to "automatic on" mode and the maximum time delay before turning off light fixtures. Verify proper operation of all sensors. The sensing units' coverage area shall be

restricted if required to avoid sensing people or extraneous influences in adjacent areas or corridors. This shall be done by covering a portion of the sensing lens with white paper tape in accordance with manufacturer's recommendations.

- D. Contractor is to provide a sufficient quantity and layout of occupancy sensors to properly meet coverage and intended sequence of operation. Locations shall be carefully selected to insure that coverage patterns are unobstructed.
- E. Mount occupancy sensors and photocells in finished spaces according to manufacturer instructions. In unfinished spaces or where ceiling-type sensors are installed where there is exposed structure, mount the sensors in surface mounted outlet boxes.
- F. Mount exterior photocells on flush-mounted outlet boxes.
- G. Wiring shall be arranged as shown on the shop drawings. Wiring and cable shall be installed in raceways or cable trays, except low-voltage cables run above accessible ceilings. Raceways shall be grounded to the power system ground.
 - 1. CAT5 cables connect control devices in uninterrupted continuous runs without intermediate splices. Cables shall be free from shorts or ground and shall be tested.
 - 2. Cables shall be routed so as to maintain a separation of at least 610 mm (24 in) from all heat sources and from ballasts, transformers, dimmers and other sources of electromagnetic interference. Avoid exposed cables in occupied areas or in areas where they might be damaged as a result of normal use of the area. Where two (2) or more cables run in parallel, they shall be bundled with cable ties
 - 3. Cables run exposed in ceiling cavities shall be supported by means of suitable cable support devices from the building structure. They shall not lie upon the ceiling, nor shall they be supported from the ceiling frame, ceiling suspension wires, conduits, pipes, ductwork or lights. Supports shall be spaced no further apart than 4 feet on center.
 - 4. Care shall be exercised during cable installation not to damage cable insulation. Damaged cables shall be removed and replaced. Type and spacing of supports shall ensure that cable will not kink or sag.
 - 5. In each cable that terminates at a ceiling device, provide 305 mm (12 in) of slack cable, neatly coiled, to facilitate future modifications. Terminations shall be made in a neat and workmanlike manner.
 - 6. Terminate the manufacturer's recommended cable type to the appropriate termination point (RJ45 jack, etc.). Do not use CAT 5 cable for terminating to blocks.
 - 7. Cabling for 0-10V dimming control shall be installed in raceway (1/2" EMT), except where installed above accessible ceiling. Raceway shall be installed orthogonal to room surfaces, and be concealed by structure wherever possible.
 - 8. CAT5 networked control cable shall be run orthogonal to room surfaces, be routed along edges of rooms and concealed by structure wherever possible. Provide identification for control devices (Device ID #'s) per manufacturer instruction.

3.2 ADJUSTMENT, TESTING & DEMONSTRATION

- A. Notify the Owner's Representative and the Commissioning Authority at least two (2) weeks in advance of the date of each test, to allow witnessing of the tests if desired.
- B. The automatic lighting control devices are subject to commissioning. Assist the Commissioning Authority with scheduling and coordinating commissioning activities, developing commissioning test procedures, conducting commissioning tests, preparing commissioning documentation, and developing a training plan in accordance with specific responsibilities as assigned in Section 019100 and Section 260510. Prior to the start of functional performance testing for commissioning purposes, complete all start-up and checkout procedures and verify that the equipment is completely ready to be tested. A knowledgeable electrician in the employ of the Electrical Installer shall be present during functional performance testing for commissioning purposes.
- C. The contractor is to supply tools, instruments, gauges, testing equipment, protective devices and safety equipment for adjustment, testing and demonstration as needed.
- D. Prior to system testing, prepare a list of the devices to be tested, together with the associated location of each device and device identification (bar code number, ID, etc.). Include space to indicate test response for each device.
- E. During adjustment and testing, carefully record all settings and all test results, including expected test results, actual test results, and corrective actions taken. Records shall be submitted to the Architect's Consultant and included in the Operating & Maintenance Manuals. Settings of devices from software is acceptable documentation
- F. Initial Set-up: Verify that wiring is correctly connected to each device. Adjust controls to function as specified under the sequence of operation. Settings shall comply with direction received from the Architect's Consultant and/or sequence of operation. Default to IES light levels if information is not available at time of initial set up.
- G. Verify sensor placement, aiming, calibration and settings to ensure trouble-free operation. Final calibration of daylight harvesting sensors and controls shall be delayed until room finishes have been completed and window treatments have been installed and are operable. Lower blinds and set the blades perpendicular to the window before calibrating day lighting controls.
- H. For each room with day lighting controls calibration shall be performed on a day with sufficient daylight. Additional visits shall be scheduled as necessary if conditions are not correct for calibration. Follow manufacturer recommendations.
- I. Program sequences of operation that include time functions to operate at times selected by the Owner's Representative. Information must be available before technician is scheduled for start-up.
- J. Field Testing: Test all system features for proper function. Tests to be performed shall include, but not be limited to, the following:
 - 1. Verify the sequence of operation for each device.
 - 2. Verify the setting and accuracy of each timing function in each device.

3. Verify that each manual override control functions properly.
4. Verify that occupancy sensors do not remain actuated due to normal conditions (e.g., air movement).
5. Verify that occupancy sensors are actuated by hand motion within the entire area of coverage.
6. Verify that occupancy sensors actuate when a person enters the area of coverage.
7. Measure the illumination level in daylight zones equipped with daylight harvesting controls.
8. Correct any deficiencies discovered as a result of the above testing, and completely retest the work affected by such corrections as part of the required installation and testing.

3.3 ON-SITE TRAINING

- A. After the system has been completed, tested and is operating properly, the manufacturer's representative shall demonstrate by actual usage, the proper operation of each system device and function in the presence of the Owner's Representative. Demonstration shall include repetition of selected field tests, as well as additional adjustment or testing required to demonstrate that the system performs in accordance with the operational description as specified herein and the Owner's operational requirements.
- B. The training shall be conducted after the Operating and Maintenance Manuals for the project are completed and available for use during the training session.
- C. Conduct two (2) hours minimum of training for the Owner's maintenance personnel in the operation and maintenance of the lighting controls and applicable software. Training time shall be extended as necessary to satisfy the Owner's Representative that all pertinent topics have been adequately covered.
- D. Maintain a training sign-in sheet, upon which participants in the training session, including the instructors, shall record their names. The training sign-in sheet shall be dated.
- E. On-site training shall follow a written training plan, prepared in advance. The training plan shall outline the topics to be covered, the publications to be used, and the training schedule.
- F. The training shall be conducted by technicians who are thoroughly familiar with the equipment and its features, and also with the Project. The training shall include instruction, field demonstration, and over-the-shoulder hands-on exercises. As a minimum, the training shall cover, but not be limited to, the following topics:
 1. General overview of lighting controls, including purpose and principle of operation.
 2. Location of lighting control components.
 3. Interpretation of equipment output devices, such as indicators and status contacts.
 4. Control adjustments and settings.

5. Operation of system controls, including over-ride switches.
 6. Recommended maintenance procedures and intervals.
 7. Operation of system software.
- G. At the conclusion of the training session, obtain written sign-off from the Commissioning Authority and the Owner's Representative. Insert a copy of the sign-off form and the training sign-in sheet into the Operating and Maintenance Manuals.

END OF SECTION 260943

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general provisions, products, and methods of execution relating to branch circuit panelboards approved for use on this project. Type, size, ratings, etc., shall be as shown on the plans and in accordance with UL Standards 50 and 67.
- B. Related Sections:
 - 1. 260526 - Grounding and Bonding for Electrical Systems
 - 2. 260553 - Identification for Electrical Systems
 - 3. 262800 - Low Voltage Circuit Protective Devices
 - 4. 264300 - Surge Protective Devices

1.2 SPECIAL REQUIREMENTS

- A. Special features such as integral surge protective devices (SPDs), etc., shall be provided as required by this Section and as noted on the Drawings or on the panel schedules.
- B. Trims shall be furnished to be compatible with type of mounting.

1.3 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Submit for approval manufacturer's shop drawings to show weights, dimensions, mounting arrangements, interconnecting diagrams, schedules of overcurrent devices, voltage ratings, and specified accessories.

1.4 QUALITY ASSURANCE

- A. The panelboards shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and shall bear the UL label.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. The Basis of Design is equipment from Square D Company to set a standard for quality. Equipment from Cutler-Hammer, Siemens Energy & Automation, General Electric, or alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

2.2 CABINETS AND FRONTS

- A. Panelboard assembly shall be enclosed in a steel cabinet. Fronts shall include doors and have flush, brushed stainless steel, cylinder tumbler type locks with catches and spring-loaded door pulls. All panelboard locks shall be keyed alike. Fronts shall have adjustable, indicating trim clamps that shall be completely concealed when the doors are closed. Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. The directory card shall provide a space at least 1/4 inch high by 3 inch long or equivalent for each circuit. The directory shall be typed to identify the load fed by each circuit. Fronts shall be of code gauge, full finished steel with rust inhibiting primer and baked enamel finish. Cabinets shall be labeled in accordance with the Drawings and Section 260000 - Electrical General Requirements.
- B. "Door-in-door" construction shall be furnished on panelboards unless otherwise noted.

2.3 SAFETY BARRIERS

- A. The panelboard interior assembly shall be dead front with panelboard front removed.

2.4 BUS ASSEMBLY

- A. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Bus structure shall allow 1, 2 and 3-pole breakers of various frame sizes to be mounted in any location and in any combination up to the capability of the panel.

2.5 SHORT CIRCUIT CURRENT RATING

- A. Each panelboard, as a complete unit, shall have a short circuit current rating (SCCR) equal to or greater than that shown on the panelboard schedule, or as necessary to comply with the requirements stated on the power one-line diagram. The SCCR rating shall not, in any case, be less than 10,000 Amps at 240 volts, and 14,000 Amps at 480 volts.

2.6 PROTECTION DEVICES

- A. Circuit breakers shall individually comply with Section 262800 – Low Voltage Circuit Protective Devices. The type to be furnished shall be as shown on the plans. If no withstand rating is specified, minimum requirements shall be as necessary to comply with the preceding requirements.

2.7 NEUTRAL TERMINAL BAR

- A. Panelboards shall be equipped with an insulated neutral terminal bar.
- B. Panelboards with integral SPDs as noted on the Drawings or further specified shall be U.L. Listed as suitable for non-linear loads.

2.8 EQUIPMENT GROUNDING TERMINAL BAR

- A. Panelboards shall be equipped with an equipment grounding terminal bar to terminate equipment grounding conductors.

2.9 HANDLE LOCK-OFF EQUIPMENT

- A. Circuit breakers serving as the required disconnecting means for appliances or other equipment shall be equipped with equipment to allow the breaker to be padlocked in the "off" position.

2.10 INTEGRAL TRANSIENT VOLTAGE SUPPRESSION

- A. Provide panelboards with integral Surge Protective Devices (SPDs) as noted on the panel schedules or drawings in accordance with Specification Section 264300 – Surge Protective Devices.
- B. Provide SPDs for emergency system panelboards.
- C. Integral SPDs shall be factory installed in the panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify mounting arrangements for each location shown on the plans. Where cabinets are recessed, verify adequate thickness of wall and make arrangements for furring or trim as required. In general, conduits shall enter the top or bottom of panel.
- B. Provide additional wire gutters or pull boxes to facilitate orderly entry of conduits into cabinets. Bundle and support wires and arrange them in an orderly manner in the designated wire gutters.

- C. Panelboards shall not be used for pull boxes for wiring not terminating in the panelboard.

3.2 SPARE CONDUITS

- A. Provide spare conduits from flush mounted panels into accessible ceiling or floor spaces as follows:

No. of Poles (Spares + Spaces)	Spare Conduits
1 - 3	One 3/4 inch
4 - 6	Two 3/4 inch
7 or more	Two 3/4 inch, One 1 inch

3.3 PANELBOARD LABELS

- A. In addition to applicable NEC requirements for emergency systems, series rated applications, etc., label panelboards in accordance with Section 260553 – Identification for Electrical Systems.
1. First line shall be panelboard name.
 2. Second line shall be voltage and phase.
 3. Third line shall indicate if panelboard is "NORMAL" (black background), or "STANDBY" (yellow background) or "EMERGENCY" (red background).
 4. Fourth line shall be source from which panel is fed, "FED FROM: PANEL NH031".

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general provisions, products and methods of execution relating to line voltage wiring devices for use on this project.
- B. Related Sections
 - 1. 260533 - Raceway and Boxes for Electrical Systems

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Do not place order for devices, plates, etc., without ensuring that the Contracting Agency has positively approved submittals for the specific colors necessary for all applications and locations. Note that the selection of one color for general use does not rule out the selection of other colors for special applications or for aesthetic reasons.

1.4 QUALITY ASSURANCE

- A. Manufacturers mentioned and catalog numbers specified are for establishment of type, configuration and quality. Other manufacturers and types may be submitted for approval.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Catalog numbers shown are Hubbell unless noted otherwise. Equal devices manufactured by Arrow Hart (by Cooper Wiring Devices), Pass and Seymour, Leviton and Bryant are acceptable. Provide all similar devices of same manufacturer.

2.2 SWITCHES

- A. Provide 20 AMP, 120V rated switches with UL listing for tungsten lamp loads or inductive loads without derating. Switches shall be as follows:

	20A Rated Switches
Single Pole	CAT. NO. 1221
Three-way	CAT. NO. 1223
Four-way	CAT. NO. 1224
Key Operated	CAT. NO. HBL1221-L
Momentary Cont.	CAT. NO. HBL1557
Double Pole	CAT. NO. 1222
Pilot Switch	CAT. NO. HBL1221-PL

- B. Other switch types shall be provided as called for on the Drawings or as required by the application.

2.3 RECEPTACLES

- A. Insofar as commercially available, receptacles shall be of nylon construction. Provide grounding type receptacles as follows, or as required to match equipment furnished in this or other divisions.

Single Phase, 3-Wire Devices		
15A-125V	CAT. NO. HBL 5262	NEMA #5-15R
15A-125V GFCI	CAT. NO. HBL GF-15LA	NEMA #5-15R
15A-250V Single	CAT. NO. HBL 5661	NEMA #6-15R
Clock hanger 125V	CAT. NO. HBL 5235	NEMA #5-15R
20A-125V USB Charger Tamper Resistant	CAT. NO. HBL USB20X2	NEMA #5-20R
20A-125V	CAT. NO. HBL 5362	NEMA #5-20R
20A-125V GFCI	CAT. NO. HBL GF-20LA	NEMA #5-20R
20A-125 SPD	CAT. NO. HBL 5362SA	NEMA #5-20R
20A-125V Tamper Resistant	CAT NO. HBL 8300SG	NEMA #5-20R
20A-250V Single	CAT. NO. HBL 5461	NEMA #6-20R
30A-250V Dryer	CAT. NO. RR430F	NEMA #14-30R
50A-250V Range	CAT. NO. RR450F	NEMA #14-50R

- B. Outlets requiring ratings and configurations different from those listed above shall be provided as shown on the plans and/or required by the equipment served.

2.4 DEVICE COLOR

- A. Device color shall be as selected by Architect, unless otherwise noted.
- B. Receptacles connected to emergency power shall be red.

2.5 DEVICE PLATES

- A. Device plates shall be satin finished Type 302 stainless steel, unless otherwise noted.
- B. Indoor device plates for surface mounted boxes shall be stainless or galvanized steel, with design to match the box and device type being used.
- C. Weatherproof outlet plates shall be of the safety outlet enclosure type that can be closed to remain weatherproof while in use. The outlet cover/enclosure shall be clearly marked "Suitable for Wet Locations While In Use" and "UL Listed". A gasket shall be provided between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to ensure a proper seal. Enclosure shall be oversized depth, single-gang, vertical-mount, with non-locking latch, GFCI opening, cord openings, and cover; TayMac; Specification Grade or approved equal.
- D. Label receptacle and light switch plates in accordance with Section 260553 – Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wiring devices indicated complete with cover plates. Cover plates shall fit snugly against finished surfaces and line up true with adjacent building lines, and be symmetrical in location and appearance.
- B. Switches shall be installed so their handles move in a vertical plane.
- C. Door swings shall be checked and, if necessary, switches shall be relocated to place them on the strike side of the door.
- D. Unless otherwise noted on the drawings, receptacles shall be installed in the vertical position with the grounding pin down unless wording on the face of the device requires other mounting.
- E. Receptacles identified as Ground-Fault Circuit Interrupter (GFCI) type shall be provided as individual GFCI receptacles.
- F. NEMA 5 configuration receptacles located in shops or commercial kitchens whether on single or multiple receptacle circuits shall be rated at least 20 amps.
- G. Receptacles in pediatric locations shall be tamper resistant in accordance with NEC Article 517.

- H. Occupancy sensors shall be installed in accordance with manufacturer's recommendations. Verify proper operation of sensors. The sensing units' coverage area shall be restricted if required to avoid sensing people or extraneous influences in adjacent areas or corridors. This shall be done by covering a portion of the sensing lens with white paper tape in accordance with manufacturer's recommendations.

END OF SECTION 262726

SECTION 262800 - LOW VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermal Magnetic Molded Case Circuit Breakers.
2. Electronic Trip Molded Case Circuit Breakers.
3. Fusible switches and fuses.

B. Related Sections:

1. 262413 - Switchboards
2. 262416 - Panelboards
3. 264300 - Surge Protective Devices

1.2 REFERENCES

A. The circuit breaker(s) referenced herein shall be designed and manufactured according to the latest revision of the following standards.

1. ANSI/NFPA 70 - National Electrical Code (NEC).
2. NEMA AB 1 - (National Electrical Manufacturers Association) Molded Case Circuit Breakers and Molded Case Switches.
3. UL 489 - (Underwriters Laboratories Inc.) Molded Case Circuit Breakers and Circuit Breaker Enclosures.
4. UL 943 - Standard for Ground Fault Circuit Interrupters.
5. UL 1053 – Ground Fault Sensing and Relaying Equipment.
6. CSA C22.2 No. 5 - (Canadian Standard Association) Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures.
7. Federal Specification W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
8. Federal Specification W-C-865 - Fusible Switches.
9. IEC 60947 – Low Voltage Switchgear and Control Gear – Part 2: Circuit Breakers.

10. IEC 61000-4 Series – Electromagnetic Compatibility.

1.3 SYSTEM DESCRIPTION

- A. Provide overcurrent protective devices as specified herein and as shown on schedules and/or drawings.

1.4 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Submit product data for each type of overcurrent protective device, ground fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- C. Provide outline drawings with dimensions, and ratings for voltage, amperage and maximum interruption. Include instructions for circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.
- D. Coordination data to check protective devices: Manufacturer shall provide electronic and hard copy time/current characteristic trip curves (and I_p & I^2t let through curves for current limiting circuit breakers) for each type of circuit breaker.
- E. Provide information required to verify compliance with the short circuit withstand and interrupting ratings, as shown on the Drawings or further stated in these Specifications.
- F. Coordination Study: Provide a complete protective device coordination study for the entire electrical distribution system. Provide specific recommendations for circuit breaker settings (trip, time delays, etc.), relays and ground fault devices. The study shall be performed by a Registered Professional Engineer who has at least five (5) years experience in performing system studies.
- G. Arc Flash Hazard Analysis Study: Provide an Arc Flash Hazard Analysis Study for the electrical distribution system provided under this project per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.

1.5 QUALITY ASSURANCE

- A. Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and UL listings.
- B. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors installed in the State of Alaska must be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical

shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.

- C. The overcurrent protection device manufacturing facility shall be Registered by Underwriters Laboratories Inc. to the International Organization for Standardization ISO 9000 Series Standards for quality.

PART 2 - PRODUCTS

2.1 PRODUCT

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from Cutler-Hammer, Seimens Energy & Automation, General Electric, or alternative systems will be considered providing that sufficient documentation is provided to the Contracting Agency that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points that are pertinent to the Project.

2.2 MOLDED CASE CIRCUIT BREAKERS

- A. General Characteristics:

1. Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.
2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which shall provide quick make, quick break contact action. The circuit breaker shall have common tripping of all poles.
3. The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings.
4. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
5. Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes (except Type QO/EDB/EGB/EJB).
6. MCCBs shall be able to receive a device for locking in the isolated position. MCCBs that serve as the main service disconnect shall be provided with a device for locking in the isolated position.
7. Electronic components shall withstand temperatures up to 221°F (105°C).

8. Circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs (except Type (except Type QO/EDB/EGB/EJB/QB/QD/QG/QJ).
9. Lugs shall be UL listed to accept solid (not larger than #8 AWG) and/or stranded copper and aluminum conductors. Lugs shall be suitable for 75°C rated wire or 90 C rated wire, sized according to the 167°F (75°C) temperature rating in the NEC.

B. Trip Unit:

1. General:
 - a. MCCBs with ratings up to 400 amperes shall be equipped with thermal magnetic trip units unless otherwise noted on the drawings.
 - b. MCCBs with ratings over 400 amperes shall be equipped with electronic trip units.
 - c. Circuit breakers with permanent trip units shall be UL listed for reverse connection without restrictive line and load markings and shall be suitable for mounting in any position.
 - d. The trip units shall not augment overall circuit breaker volume.
2. Thermal Magnetic (400 Ampere Frame and Below) :
 - a. Basis of Design: PowerPact Q, H and J Frame, FA, LA, and LH as manufactured by Square D by Schneider Electric.
 - 1). General:
 - a) Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 F (40 C) ambient temperature. Circuit breaker frame sizes above 150 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker
 - 2). Type QO (for use in NQ Series Panelboards) and Type EDB/EGB/EJB (for use in NF Series Panelboards) as manufactured by Square D by Schneider Electric.
 - a) Breakers shall have two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.
 - 3). Where indicated on drawings, Circuit breakers shall be equipped with a ground fault module (GFM) with 20 ampere to 200 ampere sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equal.
3. Electronic Trip Circuit Breakers (breakers with ratings above 400 Ampere) :
 - a. MICROLOGIC Trip System:
 - 1). Basis of Design: PowerPact H, J, L, P and R Frame (15 amperes to 3000 amperes) as manufactured by Square D by Schneider Electric.
 - 2). General:
 - a) Circuit breaker trip system shall be a MICROLOGIC electronic trip unit with true RMS sensing.
 - b) Current transformers shall be used to ensure accurate measurements from low current up to high currents.
 - c) Electronic trip unit shall be fitted with thermal imaging.

- d) The following monitoring functions shall be integral parts of electronic trip units:
 - i. A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
 - ii. LED for load indication at 105 percent.
 - iii. LED for load indication at 90 percent of load for applications 600A and smaller.
 - iv. LED for visual verification of protection circuit functionality for applications 600A or smaller.
 - v. LED for trip indication for applications above 600A.
- e) MICROLOGIC trip unit functions shall consist of adjustable protection settings with the capability to be set and read locally by rotating a switch.
 - i. Long time pickup shall allow for adjustment to nine long time pickup settings. This adjustment shall be at least from 0.4 to 1 times the sensor plug (I_n), with finer adjustments available for more precise settings to match the application.
 - ii. Adjustable long-time delay shall be in nine bands. At six times I_r , from 0.5 to 24 seconds above 600A, and 0.5 to 16 seconds for 600A and below.
 - iii. Short time pickup shall allow for nine settings from 1.5 to 10 times I_r .
 - iv. Short time delay shall be in nine bands from 0.1–0.4 $I_2 t$ ON and 0 - 0.4 $I_2 t$ OFF.
 - v. Instantaneous settings on the trip units with LSI protection shall be available in nine bands.
 - Above 600A, from 2 to 15 times I_n
 - 600A, from 1.5 to 11 times I_n
 - 400A from 1.5 to 12 times I_n
 - 250A and below, from 1.5 to 15 times I_n
- f) It shall be possible to fit the trip unit with a seal to prevent unauthorized access to the settings in accordance with NEC Section 240.
- g) Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.
- h) Provide neutral current transformers for four wire systems.
- i) Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments shall be 1 ampere. Fine increments for delay adjustments shall be one second.
- j) Measurement chain shall be independent from the protection chain.
- k) The measurements shall be displayed on the breaker itself and/or on a remote display and/or on a remote system via Modbus communication.
- l) Connections from circuit breaker to remote display and/or communication module shall be plug-n-play via RJ45 connector. No special tools or programming shall be required.

C. Accessories:

1. General:

- a. Circuit breakers shall be equipped with UL listed electrical accessories as noted on the Drawings or schedules or they may be field installable.
- b. The addition of auxiliaries shall not increase the volume of the circuit breaker.

2. Electrical Auxiliaries: Electrical auxiliaries, such as voltage releases (shunt and undervoltage releases) and indication switches as follows:

- a. Same field installable auxiliary contacts for signaling different functions, such as open/ closed position, fault signal, electrical fault (including electrical leakage) signal. Auxiliaries shall be common for the entire range,
- b. Electrical auxiliaries shall be separated from power circuits,
- c. Electrical auxiliaries shall be of the snap in type and fitted with terminal blocks,
- d. Electrical auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself.

3. Handle Accessories:

- a. Provide circuit breaker handle accessories required for locking handle in the on and off position.

2.3 FUSIBLE SWITCHES

A. Main Fusible Devices

1. Fused Power Circuit Devices

- a. Individually fixed mounted bolted pressure switches through 4000 A.
- b. Each device shall have power terminals to accommodate either cable or bolted bus connections.
- c. The over current protective devices shall be of the fusible bolted pressure contact type as shown on the associated drawings.
- d. Switches, with Class L fuse installed, shall be rated for use on systems capable of delivering not more than 200,000 rms symmetrical amperes at 600 VAC maximum. Switches shall have an interrupting rating of 12 times continuous ampere rating at 240, 480, and 600 VAC. Switches shall be 100% rated devices. Lugs shall be rated for use with 90° C wire insulation (sized according to the 75° C temperature rating in the NEC).
- e. Switches shall have switch blades which are fully visible in the Open (off) position when the fuse access door is open. Bolted pressure contacts shall be made by providing an additional pressure or clamping action at both ends of the switch blade when the blades are fully closed. Switches having butt-type contacts are not acceptable.
- f. Manual operated switches shall have quick-make, quick-break front operating mechanisms.
- g. Electrically Operated Switch
 - 1). Switches shall have a manual-charging, electric trip open, quick-make, quick-break, front operated mechanism with manual override.
- h. Provisions for locking the switch in the Open (off) position with at least three padlocks shall be provided. Switches shall have dual fuse door interlock designed to prevent the fuse access door from being opened when the switch is Closed (on) and

prevents the switch being turned ON while the fuse access door is open. A means of bypassing the interlock by authorized personnel shall be provided to allow the switch to be inspected in the Closed position. An external mechanical flag shall be provided to identify whether the switch is either Open or Closed.

- i. Accessories shall be supplied as follows:
 - 1). Capacitor trip power supply
 - 2). Blown main fuse protection
 - 3). Blown main fuse indication
 - 4). Phase failure relay with capacitor trip power supply
 - 5). Key interlock
 - 6). Equipment ground fault protection
 - a) Provide a zero sequence type ground fault system including current sensor and appropriate relaying equipment. The current sensor shall enclose all phase (and neutral, if present) conductors to be monitored. The current sensor frame shall be so constructed that one leg can be opened to allow the removal of the sensor without disturbing the cables or requiring drop-links in the bussing. A test winding shall be provided to simulate the flow of ground fault current through the current sensor for testing.
 - b) The ground fault relay shall be of solid state construction and have adjustable pick-up for ground fault currents from 100 amperes to 1200 amperes.
 - c) Direct adjustable time delay shall be provided by the ground fault relay. The time delay shall be permanently calibrated to preclude tampering after installation.
 - d) Ground fault system to meet the on-site testing requirements of NEC article 230-95(c).
 - e) Ground fault system shall be Square D type GC.
- j. Switches shall be BOLT-LOC as manufactured by Square D.

2.4 ARC ENERGY REDUCTION

- A. Where the highest continuous current trip setting for the overcurrent device installed in a circuit breaker is rated or is adjustable to 1200A or higher, provide an energy reducing maintenance switch with local status indicator in accordance with NEC 240.87.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings. Install circuit breakers in accordance with manufacturer's instructions, the National Electrical Code and applicable local codes.
- B. Size devices as shown and specified, or as required by the load being served.

3.2 ADJUSTMENTS

- A. Circuit breaker pick-up level and time delay settings shall be adjusted to values indicated by the required coordination study.

3.3 ARC FLASH LABELING

- A. Provide arc flash labels for equipment that provides all of the following:
 - 1. Nominal system voltage
 - 2. Arc flash boundary
 - 3. At least one of the following:
 - a. Available incident energy level or arc flash PPE Category in NFPA 70E, Standard for Electrical Safety
 - b. Minimum arc rating of clothing
 - c. Site specific level of PPE

END OF SECTION 262800

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general requirements, products, and methods of execution relating to fusible and non-fusible disconnecting devices approved for use on this project.
- B. Related Sections:
 - 1. 260519 - Low Voltage Electrical Power Conductors and Cables
 - 2. 260526 - Grounding and Bonding for Electrical Systems
 - 3. 260529 - Hangars and Supports for Electrical Systems
 - 4. 260553 - Identification for Electrical Systems

1.2 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.

1.3 QUALITY ASSURANCE

- A. Devices shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with U.L. listings and the governing NEMA standards.
- B. Disconnects shall be of the same manufacturer as switchboards and panelboards.

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

- A. Safety switches, fusible and non-fusible, shall conform to NEMA Standard KS1 for type HD (Heavy Duty) unless otherwise noted.
 - 1. Switch Interior: Switches shall have switch blades that are fully visible in the OFF position when the door is open. Switches shall be of dead front construction with permanently attached arc suppressers. Lugs shall be UL listed for copper and/or aluminum cables and be front removable.
 - 2. Switch Mechanism: Switches shall have a quick-make and quick-break operating handle and mechanism that shall be an integral part of the box, not the cover. Switches shall

have a defeatable dual cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open. The switch shall be capable of being locked in the OFF position with three (3) padlocks.

3. Enclosures: Switch enclosure shall be suitable for the environment in which the switch is mounted. NEMA 1 enclosure shall be code gauge, UL-98, sheet steel, treated with a rust inhibiting phosphate and finished in gray, baked enamel. NEMA 3R enclosure--same requirements as NEMA 1 except galvanized prior to painting.
4. Rating: Ampere, volt and horsepower ratings, as well as number of poles and presence of neutral bar shall be shown on the nameplate.

2.2 CIRCUIT BREAKERS

- A. Circuit breakers used as disconnects shall meet requirements specified in Section 262800 – Low Voltage Circuit Protective Devices. Enclosures for same shall meet the requirements as specified above.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate details pertaining to size of motor and/or equipment, location and requirements to enclosure, ratings, etc., so as to provide the most suitable unit for the intended purpose.
- B. Provide nameplates for disconnects. Coordinate names with mechanical equipment lists.
- C. Where the rating of a fused disconnect exceeds the ampacity of the conductors being protected, a permanent label noting maximum fuse size shall be installed in a conspicuous location within the switch.
- D. Where recommended or required by the equipment manufacturer, or required by underwriters' laboratories, disconnects shall be the fusible type, fused in accordance with the equipment nameplate information.
- E. Provide code required disconnects. For equipment under the jurisdiction of the IMC, provide a disconnect within sight of the equipment.

END OF SECTION 262816

SECTION 262900 - LOW VOLTAGE CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general requirements, products, and methods of execution relating to manual and magnetic motor starters provided in this and other Divisions. Overloads shall be furnished and installed in Divisions 26, 27 and 28.
- B. Related Sections:
 - 1. 260553 - Identification for Electrical Systems

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - 4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
 - 6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.

1.4 QUALITY ASSURANCE

- A. Equipment shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with the governing standards.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

2.2 AC FRACTIONAL MANUAL STARTERS

- A. The manual starter shall consist of a manually operated toggle switch equipped with red pilot light and melting alloy type thermal overload relay.
- B. Thermal unit shall be one piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.

2.3 AC MANUAL STARTERS--LINE VOLTAGE TYPE

- A. Manual starters shall be constructed and tested in accordance with the latest published NEMA standards.
- B. The manual starters shall consist of a manually operated switch equipped with red pilot light and melting alloy type thermal overload relays in every phase conductor. Thermal units shall be one piece construction and the starter shall be inoperative if any thermal unit is removed.
- C. Starters shall be furnished in a NEMA 1 general purpose enclosure unless otherwise indicated on the plans or required by the conditions of the area in which they are installed.

2.4 AC MAGNETIC STARTERS--LINE VOLTAGE TYPE

- A. Motor starters shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes and horsepower ratings.
- B. Starters shall be mounted in NEMA 1 general purpose enclosures unless otherwise indicated on plans or required by the conditions of the area in which they are installed.
- C. Starters shall be furnished with overload relays in every phase conductor and starters shall be inoperative if any overload unit is removed.
 - 1. Overload relays shall be bimetallic type. Thermal units shall be of one-piece construction and interchangeable.
- D. Starters through NEMA size five (5) shall be equipped with double break silver alloy contacts. Contacts shall be replaceable without removing power wiring or removing starter from panel.

- E. Coils shall be of molded construction and shall be 120 VAC. Starters shall have a fused 120V control power transformer in enclosure, or alternatively on 120/208 or 120/240 volt systems, the power system neutral conductor may be utilized. In all cases, control power shall be disconnected by the starter disconnecting means, unless otherwise specifically approved.
- F. Starters shall be suitable for field addition of at least four (4) auxiliary electrical interlocks of any arrangement, normally open or normally closed.
- G. Starters shall have enclosure mounted red running pilot light and Hand-Off-Auto switch.

2.5 AC COMBINATION STARTERS WITH FUSIBLE DISCONNECT SWITCH OR CIRCUIT BREAKER

- A. Combination starters shall be manufactured in accordance with the latest published NEMA standards, sizes and horsepower ratings.
- B. Disconnect switch combination starters shall consist of a visible blade disconnect switch and a motor starter.
- C. Combination starters shall be mounted in NEMA 1 general purpose enclosures unless otherwise indicated on the plans or required by the conditions of the area in which they are installed.
- D. The disconnect handle used on combination starters shall always be in control of the disconnect device with the door opened or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".
- E. Magnetic starters provided under all Divisions of the Specifications shall be in accordance with this Section.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate details pertaining to the motor control equipment with the Division of these specifications where the equipment is specified.

3.2 CONTROL WIRING

- A. Control wiring and control devices shall be provided under the Specification Division in which the controlled equipment is specified. Coordinate all related work.

3.3 CONNECTIONS

- A. Provide liquid tight flexible conduit connections to motors and other equipment subject to vibration where LFMC is an acceptable wiring method. Provide flexible conduit connections to motors and other equipment subject to vibration that is located in spaces used for environmental air (e.g. fan rooms). Minimum length 12 inches.

3.4 NAMEPLATES

- A. Provide engraved nameplates for all starters in accordance with Section 260553 – Identification for Electrical Systems. Coordinate names with mechanical equipment lists.

3.5 REDUCED VOLTAGE STARTERS

- A. Reduced voltage starters shall be provided for all motors larger than:
208 volts 25 horsepower
 - 1. This requirement shall apply to starters furnished in this Division and other Divisions of the specifications.
 - 2. Motors controlled by Variable Frequency Drives (VFDs) are not subject to this requirement.

3.6 TWO SPEED STARTERS

- A. Provide two speed starters for all two speed motors. Starters shall comply with the requirements of the equipment and motor manufacturers. Refer to Mechanical Equipment Lists for equipment with two speed motors.
- B. This requirement shall apply to starters furnished in this Division and other Divisions of the specifications.

END OF SECTION 262900

SECTION 262916 - ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lighting contactors.

B. Related Sections:

1. 265000 - Lighting Fixtures

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.3 QUALITY ASSURANCE

- A. Contactors shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be Underwriters' Laboratory listed and bear the UL label.
- B. Contactors of each type provided shall include the features as indicated on the Drawings.

1.4 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1.
- B. Accurately record actual locations of each contactor and indicate circuits controlled.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 1.
- B. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

2.2 CONTACTOR FEATURES - GENERAL

- A. Enclosures:

- 1. For other than Panelboard Lighting Contactors, enclosures shall be ANSI/NEMA ICS 6, NEMA Enclosure Type as indicated or as required to meet conditions of the installation.

- B. Accessories:

- 1. Provide the following accessories as indicated for each contactor:
 - a. Pushbutton: ON/OFF. NEMA ICS 2, heavy duty type.
 - b. Selector Switches: ON/OFF or HAND/OFF/AUTOMATIC. NEMA ICS 2, heavy duty type.
 - c. Indicating Lights: NEMA ICS 2 type.
 - d. Auxiliary Contacts: field convertible, quantity indicated.
 - e. Other: as indicated.

- C. Coil Voltages: As indicated for each contactor.

- D. Poles: As indicated or required for the specific application.

- E. Contact Rating: As indicated or as required to meet conditions of the installation.

- F. Size: As indicated or required by the load.

- G. Configuration: Provide types as indicated:

- 1. Electrically held shall have continuously rated, encapsulated coils.
 - 2. Mechanically held shall be electrically operated with encapsulated coils. Standard coil clearing contacts shall be provided so that the contactor coils shall be energized only during the instance of operation.

2.3 MULTIPOLE LIGHTING CONTACTORS

- A. Square D Company - 8903 Type L & LX.

- B. Description: magnetic lighting contactor.

- C. Contact Rating: As indicated or as required to meet conditions of the installation.
- D. Contacts: Totally enclosed, double break silver cadmium oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring. Contacts shall have clearly visible N.O. and N.C. contact status indicators.
- E. Wiring: Straight-through wiring with all terminals clearly marked.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 NAMEPLATES

- A. Provide engraved nameplates for Contactors in accordance with Section 260553 – Identification for Electrical Systems.

END OF SECTION 262916

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SECTION 263213 - DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes the scope of work for the Emergency/Standby electric generating system on the project.

B. Related Sections:

1. 250548 - Mechanical Vibration and Seismic Control
2. 255000 - Building Automation System
3. 260000 - Electrical General Requirements
4. 263623 - Automatic Transfer Switches (ATS)

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. ANSI/IEEE 446, "Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications"

B. International Electrotechnical Commission (IEC):

1. IEC 801.2, "Electrostatic Discharge"
2. IEC 801.3, "Radiated RF Immunity"
3. IEC 801.5, "Power Testing"
4. IEC 8528-4, "Control Systems for Generator Sets"

C. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems - Requirements"

D. National Electrical Manufacturers Association (NEMA):

1. NEMA MG 1, "Motors and Generators"

- E. National Fire Protection Association (NFPA):
 - 1. NFPA 37, "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines"
 - 2. NFPA 70, "National Electrical Code"
 - 3. NFPA 99, "Standard for Health Care Facilities"
 - 4. NFPA 110, "Standard for Emergency and Standby Power Systems"
- F. Underwriters Laboratories, Inc. (UL):
 - 1. UL 142, "Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids"
 - 2. UL 499, "Standard for Electric Heating Appliances"
 - 3. UL 508, "Standard for Industrial Control Equipment"
 - 4. UL 1236, "Standard for Battery Chargers"
 - 5. UL 1446, "Standard for Systems of Insulating Materials - General"
 - 6. UL 2200, "Standard for Stationary Engine Generator Assemblies"
- G. U.S. EPA Non Road Source Emissions Standards, 40 CFR 89, "Control of Emissions from New and In Use Non-Road Compression Ignition Engines"

1.3 SYSTEM DESCRIPTION

- A. Provide and acceptance test a complete and operable Emergency/Standby electric generating system, including all devices and equipment specified herein, as shown on the Drawings, or required for the service. equipment shall be new, factory tested, and delivered ready for installation.
- B. The system shall include, but not be limited to, engine-generator, starting batteries, battery charger, remote annunciators, conduit, wire, fittings and accessories required to provide a complete operating system. Units shall be located in accordance with the plans.
- C. Provide the generator system in a fully enclosed, walk-in, sound attenuated, weatherproof housing with features, accessories and appurtenances called for in this Section and on the Drawings.
- D. The system shall comply with the applicable requirements of NFPA 110 - Emergency and Standby Power Systems for Level 1, Type 10, Class 2 systems Provide all features and accessories required.
- E. Prototype tests shall have been performed on a complete and functional unit. Component level type tests will not satisfy this requirement. Prototype testing shall comply with the requirements of NFPA 110.

- F. The generation system shall be grounded as a “separately derived system” in accordance with NEC Article 250 for grounded systems.
- G. The work also includes, but is not limited to:
 - 1. Automatic Transfer Switch(es) as specified in Section 263623.
 - 2. Hardwired connection to the Building Automation Control System to provide remote monitoring as specified in Divisions 21, 22 and 23.
 - 3. Generator vibration isolators to meet seismic requirements.

1.4 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Provide submittal data with the following information:
 - 1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
 - 2. Drawings and/or literature describing diesel engine generator set(s), switchgear, controls and other auxiliary equipment to be provided.
 - 3. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - 4. Interconnection wiring diagrams showing external connections required; with field wiring terminals marked in a consistent point-to-point manner.
 - 5. Manufacturer's installation instructions.
 - 6. Drawings of the diesel generator set offered hereunder.
 - 7. Layout Drawings of the module (housing)_ showing equipment and demonstrating required working clearances. Provide calculations for generator module wind loading, snow loading and sound attenuation performance.
 - 8. The following data in tabulated form:
 - a. Make of engine.
 - b. Number of cylinders.
 - c. Bore, inches.
 - d. Stroke, inches.
 - e. Piston displacement, cubic inches.
 - f. Piston speed, feet per minute, at rated RPM.
 - g. Make and type of generator.
 - h. Generator electrical rating, kVA or kW @ 0.8 power factor.
 - i. Exciter type.
 - j. Alternator insulation class and temperature rise.

- k. Alternator direct-axis transient reactance ($X'd$).
 - l. Alternator sub-transient reactance at standby rating of genset.
 - m. Total harmonic distortion of AC voltage at full load at 0.8 power factor, line-to-line and line-to-neutral.
 - n. Parts and service support.
 - o. Engine manufacturer's certified engine BHP curve and certified genset fuel consumption curve.
 - p. Auxiliary equipment showing options.
 - q. Manufacturers installation instructions.
9. Submit 8-1/2 by 11 literature and equipment data in hard-back, 3-hole, loose leaf binders by individual sets. Cardboard or paper binders are unacceptable.

1.5 CLOSEOUT SUBMITTALS

- A. Furnish complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system in accordance with Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two complete sets.

1.6 QUALITY ASSURANCE

- A. Provide system designed and built in accordance with NEMA, IEEE, ANSI Standards, and in accordance with NFPA and the electrical codes.

1.7 WARRANTY AND SERVICE

- A. Warranty service with no deductible shall be provided for components by a trained, certified specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site. This requirement applies to all components of the complete system.
- B. Warrant components, parts, and assemblies against defects in materials provided under this contract, and all workmanship, for a period of five (5) years or 3,000 operating hours (whichever comes first) after Final Acceptance of this work.
- C. Warranty response time shall not exceed four twenty four (24) hours.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. Provide a diesel-generator set of the latest commercial type and design. In a standby capacity, it shall be capable of continuous service at rated output for the duration of any utility power failure. The engine and generator shall be the product of one company. It shall be a new, factory assembled and tested set as manufactured by **Cummins Power Generation**, which is the Basis of Design system shown on the Drawings. The engine and generator set shall have undergone comprehensive prototype testing to ensure acceptable performance at rated load and power factor.
- B. Alternative systems manufactured by **Caterpillar Company** and **Kohler** will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the specification, and that impacts of substituting an alternate to the Basis of Design have been addressed (performance requirements, space, size, connection requirements, etc)

2.2 RATING

- A. Rating of the diesel engine generator set shall be based on operation of the set when equipped with required operating accessories such as radiator, fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injector pump, jacket water pump, governor, charging alternator, alternating current generator and exciter regulator.
- B. The diesel engine generator set shall be capable of producing **150** kW at 0.8 power factor continuously for standby power applications and **135** kW at 0.8 power factor continuously for prime power applications at the ambient and altitude conditions stated in Section 2.1. The output voltage shall be **208** volts, 4-wire, 3 phase, 60 Hertz.
- C. Engines with special fuel requirements are not acceptable. Engine shall obtain rated output with No. 1 or No. 2 diesel or heating fuel.

2.3 SEQUENCE OF OPERATION

- A. Refer to Section 263623 - Automatic Transfer Switch for additional information regarding transfer switch operation.
- B. Upon failure of the normal (utility) power source, the engine shall start and the emergency ATS shall connect the emergency load to the generator within 10 seconds.
- C. After a 60 second (adjustable from 1 to 120 seconds) delay the standby ATS shall connect the standby load to the generator set.
- D. Upon restoration of normal (utility) power, the generator shall delay retransfer of standby load to the normal power source for 14 minutes (adjustable), and emergency load for 15 minutes (adjustable).

- E. If the emergency source fails the transfer switch shall immediately retransfer to the normal source.
- F. After retransfer of load to the normal power source the engine shall run for a minimum 5 minute cool-down period.

2.4 ENGINE

- A. The engine shall be a compression ignition engine, naturally aspirated or turbocharged and/or aftercooled. It shall be a four stroke cycle, liquid cooled, direct-injection engine of either in-line or V-type. Two stroke cycle engines will not be approved and shall not be submitted.
- B. Certified engine horsepower curves shall be submitted showing the manufacturer's approval of the engine rating for generator set standby and prime power application. Special ratings or "maximum" ratings are not acceptable.
- C. The engine shall be 1800 RPM at normal operation.
- D. The engine shall be capable of satisfactory performance on commercial grades of distilled petroleum fuel oil, including No. 1 and No. 2 diesel and heating fuels.
- E. Governor: The engine speed shall be governed by an isochronous electronic governor to maintain governed speed within $\pm 0.25\%$ of rated frequency from steady state no load to steady state full load generator output.
 - 1. The frequency regulation from no load to rated load shall be in accordance with that defined by the engine governor performance. For any addition of load up to 100% of rated load, the frequency shall recover to the steady state frequency band within 7.0 seconds.
- F. The fuel system shall be that which is normally used by the diesel engine manufacturer. It shall include a replaceable element fuel filter and fuel/water separator, both conveniently located for servicing.
 - 1. Steel braid reinforced flexible fuel lines shall be furnished for each fuel connection to the engine. Refer to Divisions 21, 22 and 23 for day tank requirements.
- G. The engine shall have a gear type lubricating oil pump for supplying oil under pressure to main bearings, crankpin bearings, pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism.
- H. Threaded spin on type full flow lubricating oil filters, conveniently located for servicing, shall be provided. Filter housing, integral to engine lubrication system, shall be equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged.
- I. Engine jacket water or air-to-air cooled and engine manufacturer approved aftercooler or intercooler may be furnished.

- J. The engine shall be equipped with either 12 or 24 volt negative ground electric starting system of sufficient capacity to crank the engine at a speed that will allow full diesel starting of the engine.
 - 1. Lead acid batteries shall be furnished having sufficient capacity for cranking the engine for at least two complete cranking cycles (3 @ 15 second crank cycles and 3@ 15 second rest periods) at firing speed in the ambient temperature specified. A battery rack and necessary cables and clamps shall be provided.
 - 2. The charging alternator shall have sufficient capacity to recharge the batteries at their 3-hour rate.
 - 3. A current limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, temperature compensated voltage regulator, 12 hour equalize timer, DC ammeter and voltmeter and input and output fuses. AC input shall be as required or as shown on the Drawings and output shall be rated at not less than 10 amperes. Provide monitoring of the battery charger in accordance with NFPA 110 as noted elsewhere in this section.
- K. The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the diesel generator set, with all engine driven accessories, is delivering full rated load at specified ambient temperature and altitude limits, with specified coolant protection.
 - 1. The engine shall be equipped with an engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
 - 2. Antifreeze - the engine cooling system shall be filled with a minimum concentration of 50% ethylene glycol antifreeze with corrosion inhibitors and water pump lubrication per the engine manufacturer's recommendations. Propylene glycol protection may be submitted for approval if acceptable to the equipment manufacturer.
 - 3. The engine shall be equipped with a radiator, blower fan, and close fitting venturi shroud of a type and capacity recommended by the engine manufacturer. A rigid guard shall enclose both top and sides of moving parts between the engine and radiator.
 - 4. For installations in an enclosed space, specify dimensions of radiator core and the flow of cooling air, in cubic feet per minute, required for proper cooling of the engine and generator.
 - 5. The radiator shall be sized to operate safely at anticipated ambient temperatures, and shall be equipped with a duct adapter flange. Coordinate duct connections with Divisions 21, 22 and 23.
 - 6. Prototype testing shall verify that the exact engine, fan and radiator combination provided is suitable for operation in the specified ambient conditions.
- L. A suitable silencer, of the critical residential type shall be provided with the engine. Silencer shall slope down away from the inlet (engine exhaust) and a condensate drain valve shall be provided at the low point.

1. A flexible continuous, bellows type stainless steel seamless exhaust pipe at least 24 inches long shall be furnished for the engine exhaust outlet. The pipe outlet connections shall be compatible with standard ASA 125 pound pipe flanges.
 2. Mounting of the exhaust silencer shall be coordinated with Divisions 21, 22 and 23. Silencer shall be mounted so that its weight is not supported by the engine.
- M. The engine and generator shall be equipped with suitable full length sub base for mounting the engine generator unit, including radiator.
- N. The generator shall be equipped with pad type isolators between the sub base and the floor. Coordinate floor mounting and reinforcing requirements and installation with other applicable Divisions. Isolators shall be suitable for the site seismic requirements.
- O. Furnish a drip pan under engine. Drip pan shall extend full length and width of engine and shall have 3/4 inch minimum depth.
- P. Engine crankcase breather shall be equipped with a filter system (Nelson Emission Absorber or equal). Filter system shall be sized to handle the full engine blow by volume at end of engine service life, with the filter at end of service interval, without exceeding backpressure limitations on the crankcase breather. The housing of the filter system shall be installed in such a manner that the filter element(s) can be changed without removing any accessory equipment. The output of the filter system shall be ducted into the atmosphere side of the engine air filter in such a manner that it does not significantly hamper servicing of the air filter element(s). Oil drain line from the filter system shall be plumbed, without valves, into the engine oil sump below the minimum oil level line, at a location that does not interfere with other features.

2.5 ALTERNATOR

- A. The alternator shall be a brushless, revolving field type, coupled directly to the engine flywheel through a flexible driving disc for positive alignment. The generator housing shall bolt directly to the engine flywheel housing. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% over speed.
- B. The alternator shall comply with NEMA standard MG1, Part 22. Insulation shall be class H as recognized by NEMA. The temperature rise of alternator components for the class insulation being furnished, and as measured by the resistance method at the voltage specified shall be in accordance with NEMA standard MG1-22.40 for prime operation. The generator shall be fully guarded per NEMA MG1-1.25. The maximum temperature rise shall be 125°C with Class H.
- C. Generator Excitation System Excitation system shall be the permanent magnet "PMG" type. The PMG and associated controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for up to 10 seconds.
- D. The rotor shall be layer wound with thermosetting epoxy between each layer plus a final coat of epoxy for moisture and abrasion resistance. Amortisseur windings shall be integral with the rotor coil support. The rotor shaft bearing shall be shielded type with provisions for easy

servicing through grease pipes that extend to the exterior of the generator frame. The bearing shall be designed for a minimum B-10 bearing life of 40,000 hours.

- E. The generator shall be furnished with a load connection box such that load conductors can enter the top or bottom of the junction box.
- F. Voltage Regulation:
 - 1. The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. The system shall be immune to misoperation due to load induced voltage waveform distortion and shall provide a pulse width modulated output to the alternator exciter.
 - 2. The voltage regulation system shall be equipped with three phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, that shall reduce output voltage in proportion to frequency below a threshold of 58 Hz.
 - 3. The voltage regulator shall include adjustments for gain, damping and frequency roll-off. Adjustments shall be broad range, and shall be made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level.
 - 4. The balanced telephone influence factor (TIF) shall not exceed 50.
 - 5. For any addition of load up to and including 100 percent of rated load, at 0.8 power factor, the voltage dip shall not exceed **25%** of rated voltage. The voltage shall recover to and remain within **1%** of steady state in not more than **4** seconds.

2.6 ENGINE-GENERATOR SET CONTROL

- A. The control shall be in compliance with NFPA 110 for a Level 1, Type 10 system and have automatic remote start capability from a panel-mounted 3-position (Stop, Run, Remote) switch.
- B. Provide cycle cranking of 15 SEC (ON) 15 SEC (OFF) for three attempts (75SEC). If engine fails to start lockout the engine and indicate overcrank on alarm status panel.
- C. The control shall shut down and lock out upon: failing to start (overcrank), overspeed, low lubricating oil pressure, high engine temperature, or operation of a remote manual stop station. A panel mounted switch shall reset the engine monitor and test all the lamps. Lamp indications on the control panel shall include:
 - 1. Overcrank shutdown - red.
 - 2. Overspeed shutdown - red.
 - 3. Low oil pressure shutdown - red.
 - 4. High engine temperature shutdown - red.
 - 5. High engine temperature pre-alarm - yellow.

6. Low engine oil pressure pre-alarm - yellow.
 7. Low coolant temperature - yellow.
 8. Low fuel - yellow.
 9. Run - green.
 10. Generator breaker position.
 11. Not in automatic start - flashing red.
 12. Auxiliary (2 each) - red. (Customer identified)
- D. The NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. A front control panel illumination lamp with ON/OFF switch shall be provided. Control panel mounted indicating meters and devices shall include: Engine Oil Pressure Gauge, Coolant Temperature Gauge, DC Voltmeter, and Running Time Meter (hours), Red Emergency Stop Push-button.
- E. Voltage adjusting rheostat, locking screwdriver type, to adjust voltage $\pm 5\%$ from rated value; Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90 degree scale, ± 0.6 Hz accuracy. Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.

2.7 ACCESSORIES

A. Alarm and Status Annunciator System:

1. A remote mounted annunciator panel (location shown on building plans) shall be provided to give visual and audible indication of impending alarm conditions, engine failure conditions and monitor certain operational functions. It shall conform with the requirements of the National Electrical Code, Section 700 and the National Fire Protection Association publications NFPA 99 and 110. Battery conditions noted elsewhere in this section shall also be monitored at the remote mounted annunciator panel.

B. Main Line Molded Case Switch:

1. A main line molded case 3-pole switch sized per drawings shall be provided. Switch shall operate manually as an isolation switch.
2. Overcurrent and short circuit protection shall be provided by the Onan AmpSentry protection system.
 - a. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down

- and lock out the generator set when output current level approaches the thermal damage point of the alternator.
 - b. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
 - c. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded .
 - d. An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
3. Molded case switch shall have auxiliary contacts for position indication to be annunciated at generator and remote panel.

2.8 COOLING

- A. The engine shall be radiator and fan cooled. The system shall be capable of cooling the engine under full rated load.

2.9 FUEL SYSTEM

- A. Engine shall have integrally-mounted **500** gallon UL Listed double wall fuel tank located within the skid base of the generator. The tank shall have: manual fill/vent cap, supply and return lines, and low fuel level alarm. Fuel inlet shall be provided with electric fuel solenoid valve on fuel supply line to prevent loss of prime from fuel storage tank. A water separator fuel filter and bayonet fuel gauge shall be supplied.

2.10 INSULATED WALK-IN GENERATOR ENCLOSURE

A. General:

1. Provide an insulated walk-in type enclosure to house a diesel driven electric generator and associated accessories. Provide all systems necessary to ensure the generator set will start and be ready to assume the facility standby loads within ten seconds.

B. Base and Foundation:

1. The enclosure shall be set on an adequately sized, reinforced, concrete pad The enclosure frame shall have provisions included for seismic restraints to prevent movement during an earthquake as defined by UBC Seismic Zone 4. Fork pockets shall be included in the enclosure frame, and provisions for lifting by crane with the use of spreader bars shall be included at each corner of the container.

C. Enclosure Construction:

1. The enclosure shall be constructed of a welded steel framework, welded steel base, and welded convoluted sheet steel exterior walls. The interior floor shall be welded sheet diamond deck, applied over the original hardwood floor. An angle iron lip shall be continuous welded to the interior steel floor to act as a leak free containment basin for the fuel system. An insulated "Steelcase " type personnel door shall be installed in one side of the enclosure; it shall have a locking passage set with a lever type exterior handle, and a pushbar interior opener, and shall open to the outside. The interior walls and ceiling shall be insulated with a minimum of 2 inches foam, and faced with a riveted or sheet metal screwed, galvanized steel sheeting or other acceptable material. All doors and openings to the enclosure shall have silicon rubber seals. The interior floor shall be cleaned and painted with an anti-skid industrial duty light gray paint; the exterior shall be cleaned, primed, and finish coated with an industrial paint system with color selected by the Contracting Agency.

D. Enclosure Electrical System:

1. A totally self-contained building electrical system shall be installed. 120/208 volt, 3-phase power will be supplied from a shore power connection on the outside of the enclosure, accessed by connections in a pull box. During emergency power situations, a circuit from the emergency distribution shall continue to provide power to the enclosure. Power shall be fed through a load center with main disconnect circuit breaker, and individual branch circuit breakers as required. The interior equipment shall include, but not be limited to:
 - a. Three 120 volt AC Lights, vapor tight with guards and switch.
 - b. Battery-powered emergency light.
 - c. One 208 volt (nominal) 5 kW space heater with thermostat control to maintain space temperature in all ambient conditions.
 - d. One set 24 volt motorized radiator shutters; these shutters shall open partially upon initial engine start, and modulate during operation from a thermostat control installed in the engine return water line.
 - e. One 120 volt engine jacketwater heater circuit.
 - f. One 120 volt service for a minimum 24 volt DC 6 amp battery charger.
 - g. One 120 volt duplex wall outlet.
 - h. One 24 volt DC light, vapor tight with guard and timer switch, to operate from the engine starting batteries.
 - i. One wall mount pull box with dry contacts for connection to a remote alarm panel to indicate a common generator fault, and generator running. Access shall be provided
 - j. One 120 volt power source for the engine crankcase breather heat tape.
 - k. All wiring between the accessories and the load center shall be installed in EMT. AC and DC wiring shall be in separate conduits.
 - l. Flexible sections shall be installed at points where contact is made with vibrating equipment.
 - m. Provide a complete grounding system per the NEC, including grounding of module frame, genset frame, bonding to slab reinforcement, and two (2) driven ground rods separated by at least 10 feet.

E. Enclosure Heating and Ventilation:

1. The enclosure will be provided with a thermostatically-controlled heating and ventilation system. During availability of normal power, all louvers will be closed. The wall

mounted electric heater shall be adjusted to run at 40 degrees F, and shut-off at 60 degrees F. An interlock shall be provided to deactivate the heater once the generator set has started. Power louvers shall be installed in the door end of the enclosure, with a close-fitting, weather-sealed sheet metal shroud, to limit infiltration of cold air into the enclosure. A duct transition from the engine radiator shall be installed; it shall have a flexible section to limit transmitted vibration from the engine to the enclosure. The louvers shall be installed inset into the enclosure to allow the end doors to be closed for protection during shipment to the project. Upon starting of the engine, the louvers shall open enough to allow adequate engine combustion air and a minimum air flow through the enclosure for cooling purposes. As the engine warms, they shall progressively open and modulate as required to maintain the engine at its specified operating temperature. Gravity (power) activated air inlet louvers shall be installed in either the opposite end or in the sides of the enclosure to provide airflow through the enclosure. The radiator louvers shall be thermostatically-controlled from the engine jacketwater, and with a temperature range as selected by the engine supplier.

F. Engine Exhaust System:

1. A side inlet, critical degree exhaust silencer shall be installed inside the enclosure. The system shall be complete with all mounting hardware, flexible exhaust fitting, ventilated roof thimble, rain drip shield, outlet pipe extension, and interior insulation wrap on the pipe which will limit the exterior temperature to 150 degrees F. The exterior portions of the exhaust system may be shipped loose for field installation.

G. Engine Starting System:

1. The engine shall be equipped with a 12 or 24 volt DC electric starting system, battery set, and battery charger as detailed elsewhere in this specification. The battery charger shall be wall-mounted and powered from the house load center. Batteries shall be enclosed in fiberglass battery boxes with covers, secured to the floor to prevent movement.

H. Miscellaneous Systems:

1. The engine crankcase vent hose shall be piped to discharge at the lower front of the radiator; the line shall be heat-taped to prevent freezing of the line in low ambient temperature operation. For closed loop circuit vent systems, provide a Racor or Airsep style separator system.
2. An emergency manual shutoff switch shall be installed on the outside of the enclosure, near the personnel door.

PART 3 - EXECUTION

3.1 MANUFACTURE

- A. Engine-generator set shall be factory assembled, dynamically balanced and full load tested with specified coolant protection as a complete system prior to shipment as a complete assembly from the factory. Submit copy of factory test report, for testing further specified herein.
- B. Installation of engine-generator into housing assembly shall be performed by the factory or a factory-authorized dealer.

3.2 INSTALLATION

- A. Mount engine-generator on vibration isolators in accordance with manufacturer's requirements and Section 260529 - Hangers and Supports and Section 25 0548 – Mechanical Vibration and Seismic Control.
- B. Mount module on pad securely to prevent movement. Comply with IBC Seismic requirements.
- C. Seismic anchorage shall be adequate for IBC Seismic Requirements and in accordance with Section 260529 - Hangers and Supports and Section 25 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control.
- D. Provide a separate dedicated conduit for the engine start conductors from the generator to each transfer switch. Minimum size 1 inch.
- E. Mount batteries adjacent to engine. Make connections to starter and battery charger.
- F. Emergency system wiring shall comply with NEC Article 700. Standby system wiring shall comply with NEC Article 702.
- G. Install equipment in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- H. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- I. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- J. Equipment shall be initially started and operated by representatives of the manufacturer.

- K. Equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.3 FACTORY TESTS

- A. Equipment supplied shall be fully tested at the factory for function and performance. Provide a minimum of (1) hour factory test, consisting of 1/4, 1/2, 3/4, and full load. Submit test results prior to on-site test. Verify proper functionality. Record all tests including voltage and frequency dip responses and steady state values. Include test results in O&M Manuals.

3.4 ON-SITE ACCEPTANCE TEST

- A. Fill day tank and main fuel tank. Furnish all consumable products for testing. At end of test refill day tank and main fuel tank.
- B. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- C. Installation acceptance tests to be conducted onsite shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
- D. Furnish maintenance records for Owner's use.
 - 1. Manufacturer's recommended periodic unit tests.
 - 2. Starting battery inspection/maintenance.
 - 3. System coolant, lubricant and other fluid inspection and replacement.
 - 4. Routine replacement parts such as filters.
 - 5. All other required maintenance to comply with NFPA 110, preserve the warranty and ensure long, reliable operation of the equipment.

3.5 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. Training dates shall be coordinated with and acceptable to the Contracting Agency.
- B. Furnish maintenance records for Owner's use.

END OF SECTION 263213

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SECTION 263623 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section describes the scope of work for the Automatic Transfer Switches (ATS) on the Project.

B. Related Sections:

1. 019100 - Commissioning
2. 260000 - Electrical General Requirements
3. 263213 - Diesel Engine Driven Generator Sets

1.2 REFERENCES

- A. UL 1008 Transfer Switch Equipment
- B. NFPA 110 – Emergency and Standby Power Systems
- C. NFPA 70 – National Electrical Code
- D. International Building Code (IBC) Seismic Certification

1.3 SYSTEM DESCRIPTION

- A. The automatic transfer switch system shall include, but not be limited to transfer switch(es), conduit, wire, fittings and accessories required to provide a complete operating system. Unit(s) shall be located in accordance with the plans.
- B. The system shall comply with the applicable requirements of NFPA 110 - Emergency and Standby Power Systems.
- C. Provide automatic transfer switch(es) with number of poles, amperage, voltage, withstand current ratings as shown on the Drawings.

1.4 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 and Division 1.
- B. Provide submittal data with the following information:

1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 2. Drawings and/or literature describing transfer switch equipment and other auxiliary equipment to be provided.
 3. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 4. Interconnection wiring diagrams showing all external connections required with field wiring terminals marked in a consistent point-to-point manner.
- C. Clearly mark out superfluous information.

1.5 CLOSEOUT SUBMITTALS

- A. Furnish complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system in accordance with Section 260000 and Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two complete sets.

1.6 QUALITY ASSURANCE

- A. The automatic transfer switch(es) shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be listed in the Underwriters' Laboratory and bear the UL label.

1.7 WARRANTY AND SERVICE

- A. Warranty service with no deductible shall be provided for all components by a trained, certified specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site. This requirement applies to all components of the complete system.
- B. Warrant all components, parts, and assemblies against defects in materials provided under this contract, and workmanship, for a period of one (1) years after Final Acceptance of this work.
- C. Warranty response time shall not exceed twenty four (24) hours.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. Equipment specifications for this project are based on transfer switches manufactured by ASCO (7000 Series). Equipment by Cummins Power Generation or other manufacturers that meets the requirements of this Specification are acceptable provided sufficient documentation is submitted to verify compliance with specification requirements. Proposals shall include a line by line compliance statement based on this Specification.

2.2 AUTOMATIC TRANSFER SWITCH GENERAL REQUIREMENTS

- A. Provide complete factory assembled power transfer equipment with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, positive mechanical and electrical interlocking, and mechanically held contacts.
 - 1. "ATS-E": Emergency transfer switches shall energize NFPA 101 Life Safety Systems via the building NEC Article 700 Emergency Systems Wiring.
 - 2. "ATS-S": Standby transfer switches shall energize standby loads via the building NEC Article 702 Optional Standby System.
- B. Ratings:
 - 1. Refer to the Drawings for the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings.
 - 2. Main contacts shall be rated for 600 Volts AC minimum.
 - 3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 - 4. Transfer switch equipment shall have withstand current rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the Drawings.
 - a. The transfer switch shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1-1/2 and 3 cycle ratings unless a withstand period of greater than 3 cycles is specified herein or on the project drawings.
- C. Construction:
 - 1. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single or dual solenoid mechanism, momentarily energized.
 - 2. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

3. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be disconnected and serviced without disconnecting power from the transfer switch mechanism.
4. Four pole transfer switches shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar.

D. Connections:

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to the full rating of the transfer switch.

- E. Factory Testing. The transfer switch supplier shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

2.3 TRANSFER SWITCH CONTROL

- A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

1. The control module shall direct the operation of the transfer switch. It shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit. The control module shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance. The module's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent digital communications capability.
2. The transfer switch unit and the control module shall be mounted in the same enclosure.
3. Operation: Settings described below shall be fully field adjustable without the use of tools, meters, or power supplies:
 - a. Provide a momentary type test switch to simulate a normal source failure.
 - b. Controller Display and Keypad.
 - 1). 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.

- c. The following parameters shall 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.
- d. Instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.
- e. Voltage, Frequency and Phase Rotation Sensing:
 - 1). 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
Under voltage	N&E,3Φ	70 to 98%	85 to 100%
Overvoltage	N&E,3Φ	102 to 115%	Same as dropout
Under frequency	N&E	85 to 98%	90 to 100%
Over frequency	N&E	102 to 110%	Same as dropout
Voltage unbalance	N&E	5 to 20%	1% below dropout

- f. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- g. 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).
- h. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.
- i. System Status: The controller LCD display shall include a "System " screen which 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.
- j. Self Diagnostics 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 which may be preventing load transfer commands from being completed.
- k. Communications Interface: The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 feet) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.
- l. Data Logging: The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss.

- m. 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 in-phase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- n. Provide a circuit to cause the switch to transfer to emergency, even if normal is available, upon opening of a remote contact or toggle.
- o. Provide a selective load disconnect control circuit with time delay prior to load transfer and retransfer.

2.4 CONTROL INTERFACE:

- A. The transfer switch shall provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and shall close to start the generator set. Generator start signals shall be hardwired from each transfer switch back to the generator controls.

2.5 ACCESSORIES

- A. The following accessories shall be provided as a minimum (in addition to those normally required for proper operation):

1. Auxiliary Contacts:

- a. Four sets of Form C auxiliary contacts (closed in normal position) and one set of auxiliary contacts (closed in emergency position) for remote indication of transfer switch position.
- b. Provide terminals for remote contacts that open to inhibit transfer to emergency and/or retransfer to normal.
- c. Provide one set of auxiliary contacts rated 10 amps, 240V AC, consisting of one contact closed when the ATS is connected to normal source and one contact dosed when the ATS is connected to alternate source.
- d. Provide one set of signal lights to indicate when the ATS is connected to normal source and when the ATS is connected to alternate source.
- e. Two sets of form C auxiliary contacts to monitor bypass switch status.

2. Generator Condition Controls:

- a. Provide a voltage and frequency sensitive lockout relay that monitors and prevents transfer until the voltage and frequency of the generator have reached the pre-set rating. Initially set to 95%.

3. Exercising Timer:

- a. Provide an engine generator exercising timer built into the ATS control module that includes a selector switch to select exercise with or without load transfer. The exerciser shall be programmable to enable exercise for 1 minute to 24 hours per day in 1 minute increments for 0 to 7 days per week. The exercising timer shall be ASCO accessory 11G.

4. Elevator and Variable Speed Drive Signal Contacts:

- a. In standby Automatic Transfer Switch, provide two time delay contacts that open (adjustable from 1-120 seconds) before transfer in either direction and reset after transfer.

5. Power Manager

- a. Provide a Power Manager flush in each ATS enclosure door. Power Manager shall be similar to ASCO accessory 135L.
- b. The Power Manager shall be listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20°C to 60°C.
- c. The Power Manager shall be accurate to 1% measured, 2% computed values and display resolution to 0.1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).
- d. The Power Manager shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32 VDC.
- e. Each Power Manager shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.
- f. The Power Manager shall accept inputs from industry standard instrument transformers (120 VAC secondary PTs and 5A secondary CTs.) Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PTs.
- g. The Power Manager shall be applied in single, 3-phase, or three & four wire circuits. A fourth CT input shall be available to measure neutral current.
- h. All setup parameters required by the Power Manager shall be stored in non-volatile memory and retained in the event of a control power interruption.
- i. The Power Manager shall be equipped with an continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:
 - Line-to-neutral voltages (V_{AN} , V_{BN} , V_{CN})
 - Line-to-neutral voltage average (V_{AVE})
 - Line-to-line voltages (V_{AB} , V_{BC} , V_{CA})
 - Line-to-line average (V_{LAVE})
 - Current on each phase (I_A , I_B , I_C)
 - Current in the neutral conductor (I_N) (optional)
 - Average current (I_{AVE})
 - Active power KW per phase and total (KW_A , KW_B , KW_C , KW_T)
 - Reactive power, KVAR per phase and total
($KVAR_A$, $KVAR_B$, $KVAR_C$, $KVAR_T$)
 - Apparent power, KVA per phase and total
(KVA_A , KVA_B , KVA_C , KVA_T)
 - Watt demand and maximum watt demand
 - KWHour importing, exporting and net (KWH_{IMP} , KWH_{EXP} , KWH_{NET})
 - KVARHours leading, lagging and net
($KVARH_{LEAD}$, $KVARH_{LAG}$, $KVARH_{NET}$)

- KVAHour importing, exporting and net (KVAH_{NET})
 - Power factor (PF)
 - Signal frequency (Hz)
- j. Displaying each of the Power Manager quantities shall be accomplished through the use of menu scroll buttons.
 - k. For ease in operator viewing, the display shall remain on continuously, with no detrimental effect on the life of the display.
 - l. Setup for system requirements shall be allowed from the front of the Power Manager.
 - m. Reset of the following electrical parameters shall also be allowed from the front of the Power Manager: Real energy (MWH), apparent energy (MVAH) and reactive energy (MVARH).
 - n. All reset and setup functions shall have a means for protection against unauthorized/accidental changes.
 - o. Power Manager Input/Output requirements:
 - 1). Power Manager shall be equipped with the following I/O: eight (8) solid state status inputs, four (4) relay output contacts.
6. Provide additional accessories as required to achieve the required operations.

2.6 ENCLOSURE

- A. Transfer switches shall be mounted in NEMA 1 enclosures unless otherwise designated on the Drawings or required by the environment in which it is installed.
- B. The cabinet door shall be key lockable.

2.7 NAMEPLATES

- A. Provide engraved nameplates in accordance with Specification Section 260553.

PART 3 - EXECUTION

3.1 FACTORY TESTS

- A. Each transfer switch supplied shall be factory tested before shipment. Factory tests shall include a complete functional test of the transfer switch controls, including calibration of the voltage sensors.

3.2 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 019100 – Commissioning.

3.3 INSTALLATION

- A. Install equipment in accordance with final submittals and Contract Documents. Installation shall comply with applicable state and local codes as required by the Authority Having Jurisdiction. Install equipment in accordance with manufacturer's instructions.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system.
- C. Emergency system wiring shall comply with NEC Article 700.
- D. Standby system wiring shall comply with NEC Article 702.
- E. Equipment shall be installed in accordance with the seismic requirements of the site.
- F. Install all required engine starting signal circuitry from switch(es) to generator. Engine start signal shall be transmitted automatically upon loss of normal source voltage. Provide a separate dedicated conduit for the engine start conductors from each transfer switch to the generator set. Minimum size 1 inch.

3.4 SEQUENCE OF OPERATION

- A. Upon failure of the normal (utility) power source, the engine shall start and the emergency ATS shall connect the emergency load to the generator within 10 seconds.
- B. After adjustable delay the standby ATS shall connect the standby/optional load to the generator set.
- C. Upon restoration of normal (utility) power, the generator shall retransfer standby and emergency loads to the normal power source after expiration of the "retransfer to normal" time delays for each load type.
- D. If the emergency source fails the transfer switch shall immediately retransfer to the normal source.
- E. Provide load shed provisions to shed the standby load to prevent generator overload.
- F. After retransfer of load to the normal power source the engine shall run for the specified cool-down period.
- G. Field coordinate time delay settings with the Contracting Agency.

3.5 TIME DELAYS

- A. The following time delays shall be available and set according to the following table:

Name	Description	Range	Set at
Normal Failure	Delays engine starting signal to override momentary normal source outages	0-6 seconds	1 seconds
Normal to Emergency Transfer	Delays transfer to emergency source	0-60 minutes	0 seconds (ATS-E) 30 seconds (ATS-S)
Alternate source stabilization	Delays transfer to alternate source to ignore momentary transients during initial generator set loading	0-6 seconds	0 seconds
Retransfer to normal	Delays retransfer to normal (two conditions) 1 - Power failure mode; 2 - Test mode	0-60 minutes	Power Failure Mode - 15 minutes Test Mode - 0 minutes
Programmed Neutral (or provide sync check relay to prevent out of phase transfer)	Delay for switch in the neutral position (e.g. not connected to normal or alternate source)	0-5 min 59 seconds	0 seconds (ATS-E) 2 seconds (ATS-S)
Unloaded running	Allows generator to run unloaded for engine cool down	0-60 minutes	5 minutes
Pre and post transfer signal	Delay for selective load disconnect with a programmable bypass on source failures	0-5 minutes	Field Coordinate

3.6 LOAD DISCONNECT CONTROL INTERLOCKS

- A. Provide required connections to the elevator control system(s) for elevators supported by the generator system to provide time delay interlock signal prior to transfer in either direction.

3.7 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Coordinate test with the Owner and the Contracting Agency at least 3 working days prior to the test.
- B. Provide testing of transfer switch system coordinated with generator set(s) to ensure proper operation of transfer devices under actual operating conditions. Simulate power failure at each automatic transfer switch with load transfer. Demonstrate all automatic features as directed by the Contracting Agency. Record voltage, current, and frequency during each test. Monitor and verify correct operation and timing of the following applicable items:

1. Normal voltage sensing relays.
 2. Emergency voltage sensing relays.
 3. Test switches.
 4. In-phase monitor or time-delay neutral.
 5. Engine start sequence.
 6. Time delay upon transfer.
 7. Interlocks and limit switch function.
 8. Load shed control.
 9. Timing delay and re-transfer upon normal power restoration.
 10. Engine cool-down time delay and shut down.
- C. Furnish record of tests to the Owner.
- D. On site acceptance testing shall be conducted by a Factory authorized service technician thoroughly familiar with the characteristics of the system.

3.8 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be a minimum of (4) hours in duration.
- B. Contractor shall provide a minimum of one week written notification to Owner of the training schedule. Training dates shall be coordinated with and acceptable to the Contracting Agency.
- C. Provide Operation and Maintenance manual information to the Owner prior to scheduling the instruction session.
- D. The session shall be conducted by the Contractor's Representative thoroughly familiar with the characteristics of the system.

END OF SECTION 263623

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SECTION 264300 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the Surge Protective Devices (SPDs) devices for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching. The SPD devices shall be suitable for application in a Category C and B environment as described in ANSI/IEEE C62.41.
- B. Related Sections:
 - 1. 262416 - Panelboards

1.2 REFERENCES

- A. U.L. compliance and labeling: Each complete suppression device shall be listed per U.L. 1449 (current edition) as a surge protective device.
- B. SPD shall be designed to allow installation in accordance with current National Electrical Code.
- C. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits, Category B and C.
- D. NEC Article 285 - Surge Protective Devices.

1.3 SYSTEM DESCRIPTION

- A. Provide labor, materials, equipment and services necessary for and incidental to the installation of the SPD System devices as specified herein. Installations shall be completed in accordance with this specification.
- B. Provide SPDs for panelboards as indicated on the panelboard schedules or drawings.
- C. Provide SPDs for emergency system panelboards.

1.4 SPECIAL REQUIREMENTS

- A. Where this specification or Specification Section 262416 - Panelboards specify a SPD device integral to a panelboard, the SPD shall be installed at the factory, delivered, and warranted by the electrical distribution equipment manufacturer.

1.5 WARRANTY

- A. The SPD shall have a warranty period of five years, incorporating unlimited replacements of module if destroyed by transients during the warranty period.

1.6 SUBMITTALS

- A. Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Provide submittal data with the following information:
 - 1. Product data and manufacturer's installation instructions.
 - 2. Dimensional drawing of each suppressor type indicating mounting arrangements.
 - 3. UL 1449, current edition, VPR test data for all modes of SPDs.
 - 4. UL 1283, current edition. Noise Attenuation for SPDs.
 - 5. NEC Article 285 - Surge Protective Devices.
 - 6. UL Documentation verifying short circuit current rating (SCCR), Maximum Continuous Operating Voltage (MCOV) and Device Listing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable manufacturers include: Advanced Protection Technologies, Current Technology, Liebert, Square D, or approved equal. The manufacturer shall be regularly engaged in the manufacture of SPDs for at least five years. Specific products are subject to approval.
- B. Where SPDs are specified as an integral part of distribution equipment, the manufacturer of the SPD shall be partnered with the distribution equipment manufacturer in providing a UL listed device.

2.2 SPDS GENERAL

- A. SPD shall be compatible with the electrical system voltage, current, configuration and intended application.
- B. SPD shall be parallel in design.
- C. SPD shall be modular in design and MOV based. Each MOV shall be rated at 50kA each.

- D. SPD shall have a maximum continuous operation voltage (MCOV) not less than 115% of the nominal RMS voltage continuously without degradation. For example, devices that use 130V MOVs for 120V systems are not acceptable.
- E. SPD shall provide both visual and audible indication of properly performing protection for each phase.
- F. SPD shall have UL1283 EMI/RFI filtering with minimum attenuation of -50dB@100kHz.
- G. SPD shall provide full cycle tracking circuitry to provide tight transient clamping regardless of the transient position on the sine wave.
- H. SPD modules shall be thermally fused and SPD shall be capable of safely interrupting the power system's available fault current.
- I. SPD shall incorporate a low impedance surge diversion platform for the surge current path. The surge current shall be symmetrically disbursed to all suppression elements to insure equal stressing and maximum performance of the suppression elements. The surge diversion platform shall provide equal impedance paths to each suppression element for shunting of high frequency surges. The surge current diversion modules shall be bolted directly to the platform to insure reliable low impedance connections. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion.

2.3 BRANCH PANELBOARD SPD

- A. SPD shall be tested against ANSI C62.41.2 Category C high impulse and Category C low impulse transients.
- B. SPD shall be capable of surviving 5000 sequential ANSI C62.41 B impulses, without failure or degradation of UL 1449 voltage protection rating by more than 10%.
- C. SPD shall have a maximum single impulse current rating of 100kA per phase.
- D. SPD shall provide protection in the following modes and SPD shall have a U.L. 1449 voltage protection rating (VPR) as follows:

Nominal Voltage	Configuration	L-N	N-G	L-G	L-L
120/240	Grounded Neutral	700	600	700	1000
120/208	Grounded Wye	700	600	700	1000
277/480	Grounded Wye	1200	1200	1200	2000
240	Delta			1200	1500
480	Delta			1800	2000

- E. Provide overcurrent protection and a means of disconnect for the SPD. Overcurrent and disconnect devices shall be exclusively utilized for SPD. Size overcurrent protection in accordance with manufacturer's recommendations.

2.4 SPD INTEGRAL TO DISTRIBUTION EQUIPMENT

- A. SPD shall be Component Recognized in accordance with UL 1449, Standard for Safety, Surge Protective Devices.
- B. The SPD diagnostic monitoring devices shall be mounted on the front of the equipment enclosure.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 019100 - Commissioning.

3.2 INSTALLATION

- A. Provide SPDs integral to panelboards as indicated on the panel schedules or drawings and in accordance with Specification Section 262416 - Panelboards. Where SPDs are specified as an integral part of the distribution equipment, they shall be installed as follows:
 - 1. SPD shall be installed by and shipped from the electrical equipment manufacturer's factory.

END OF SECTION 264300

SECTION 265000 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general requirements, products and methods of execution relating to lighting fixtures, LEDs, LED drivers and related products approved for use on this project.
- B. The Fixture Schedule is a general guide to type, quality and other characteristics. Fixtures of equal or better performance and quality may be substituted, subject to approval.

1.2 RELATED SECTIONS

- A. 262726 - Wiring Devices
- B. 260943 - Network Lighting Controls
- C. 26 0919 - Enclosed Contactors

1.3 QUALITY ASSURANCE

- A. The fixture shall be a standard catalog item as described on the Drawings and as made by a nationally recognized manufacturer.

1.4 SUBMITTALS

- A. Provide submittals for all products in accordance with Section 260000 and Division 1.
- B. Fixture mounting shall be clearly identified on submittal information and coordinated with architectural, features, assemblies, details and reflected ceiling plan.
- C. Fixtures and poles color selection shall be clearly identified on submittal information and coordinated with architectural.

1.5 SHOP DRAWINGS

- A. Provide fabrication drawings that indicate fixture, type, kind, weight, lamp, LEDs, LED drivers, method of fitting and fastening parts together, location and number of sockets, and complete details of method of fitting suspension and fastening fixtures in place. Verify fixture dimensions with construction conditions prior to ordering fixtures.
- B. Provide wiring diagrams that indicate supply power and interconnections for lighting controls, equipment and light fixtures. Provide sufficient information to assemble and install equipment at the project site without further instructions.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Interior lighting fixtures: 36 months from date of Substantial Completion.
 - 2. Exterior lighting fixtures and poles: 60 months from date of Substantial Completion.
 - 3. Controls mounted on or integral to lighting fixtures: 60 months from date of Substantial Completion.
 - 4. LEDs and LED Drivers: 60 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide fixtures in conformance with the Fixture Schedule, with all required flanges and supports. Lighting fixtures shall be provided complete with all suspension, trim, mounting, and operating accessories normally considered necessary for a complete, functional, and safe installation, whether specifically called for in the Contract Documents or not.

2.2 LINEAR SYSTEMS

- A. Linear fixture systems shall be provided with all corners, transitions, adjustable sections, custom angles, etc., to provide continuous linear systems. These features shall be provided to center the lamp cavity(s) of the fixtures within the designated mounting space(s) (typically wall-to-wall).

2.3 LIGHT EMITTING DIODE (LED) FIXTURES

- A. LED fixtures shall comply with Illuminating Engineering Society (IES) LM-79 guidelines.
- B. LEDs shall comply with Illuminating Engineering Society (IES) LM-80 guidelines.
- C. Fixture shall have an LM-79 photometric test report from a DOE CALiPER NVLAP accredited laboratory.
- D. Fixture shall utilize components (i.e. LEDs, driver, fixture housing, etc) included in LM-79 test.
- E. Fixture shall have lumen maintenance testing with minimum test duration of 10,000 hours.
- F. Manufacturer stated end of life shall be at 70% light output. Operating life shall be no less than 50,000 hours.
- G. Color temperature, and color rendering index (CRI) shall conform to the lighting fixture schedule shown on the Drawings.

- H. Fixture components shall be lead free, mercury free and RoHS compliant.

2.4 FULLY RECESSED FIXTURES

- A. Fixtures shall have thermal protection conforming to NEC and shall so be identified as thermally protected unless fixture is:
 - 1. Identified for use and installed in poured concrete, or
 - 2. Identified as suitable for installation in cavities where the thermal insulation will be in direct contact with the fixture.

2.5 EDISON BASE "A" LAMPS

- A. Edison Base "A" lamps installed in air handling units shall be LED A19 Series 75W Equivalent, 5000K, 120V.

2.6 DRIVER DISCONNECTING MEANS

- A. In indoor locations, LED Driver(s) shall have a disconnecting means either internal or external to each luminaire to disconnect simultaneously from the source of supply all conductors of the driver and LEDs/LED boards, including the grounded conductor in accordance with National Electrical Code (NEC) Article 410.

2.7 LED DRIVERS

- A. Characteristics:
 - 1. Input: 120-277V (UL) AC, 50-60Hz
 - 2. Efficiency: >81% at full load
 - 3. Power Factor: >0.9 at full load
 - 4. Total Harmonic Distortion (THD): <20% at full load
 - 5. 0-10V compatibility
 - 6. Flicker-free dimming down to 1%

2.8 FIXTURE ACCESSORIES

- A. Lenses for recessed fixtures shall be 100 percent virgin acrylic with a minimum overall thickness of 0.125 inches, except where specifically noted.
- B. Canopies for pendant hung fixtures shall be of the ball joint type. Where more than one pendant is used per fixture, a ball joint fitting shall also be provided in the fixture end of each pendant.

- C. Furnish one tamperproof screwdriver of each type of tamperproof fixture as required by fixtures specified on this project.

PART 3 - EXECUTION

3.1 GENERAL

- A. Drivers shall be installed per manufacturer's recommendations.
- B. Fixtures with integral drivers shall have the driver installed and prewired at the factory.
- C. Internal fixture wiring shall be factory installed in multiple fixtures which share a common driver. All wiring harnesses shall include an integral copper grounding conductor.

3.2 INSTALLATION

- A. Install fixtures level, plumb and true. Align rows accurately in three dimensions.
- B. Support suspended acoustical ceiling fixtures according to the requirements of the IBC and Section 260529 – Hangers and Supports and Section 25 0548 – Mechanical Vibration and Seismic Control as well as any local amendments.
- C. Fixture pendants, canopies, blank sections, corners, tees and other such accessories shall be finished to match their respective fixture.
- D. Refer to applicable details on architectural drawings for specific mounting requirements for all fixtures with special mounting requirements such as cove-mounted fixtures and linear fixtures.
- E. For linear fixture systems, verify fixture dimensions and mounting type with other trades prior to installation.
- F. Utility Rooms: Surface ceiling mount fixtures in rooms/areas with ceilings. In areas without ceilings pendant fixtures down to bottom of structure or height indicated on the Lighting Fixture Schedule. In areas with mechanical equipment, ductwork and piping, pendant fixtures down to bottom of mechanical ductwork or piping as appropriate. Fixture pendants shall be rigid (threaded hangar rods) and shall be sway braced where pendants exceed 24 inches in length.
- G. Provide an unswitched circuit connection for the following (as applicable):
 - 1. Exit signs
 - 2. Emergency lighting units (ELUs)
 - 3. Emergency fixtures
 - 4. Emergency night lights
 - 5. Fixtures with emergency battery LED drivers

- H. Wiring for fixtures connected to emergency circuits shall be kept entirely independent of all other wiring and equipment in accordance with NEC Article 700.
- I. Clean all fixtures and lenses prior to final acceptance.

3.3 FIRE-RESISTIVE CONSTRUCTION

- A. Refer to Section 260000 Electrical General Requirements.

3.4 EXTERIOR FIXTURES

- A. Exterior fixtures, supports and pole assemblies shall be capable of withstanding 100 mph winds with gusts to 130 mph with no damage. Where the Contracting Agency or any regulatory agencies require higher values for these, the more stringent requirements shall apply.
- B. Anchor Bolts: Provide the quantity and type of anchor bolts required by the pole manufacturer. Provide flat-washers, lock-washers and hexagonal nuts. Provide template for positioning anchor bolts. All anchor bolts shall be hot dip galvanized.
- C. Poles:
 - 1. Non-anodized poles shall be factory painted with polyester powder coat. Touch up all damage to paint.
 - 2. Anodized aluminum poles shall be finished with an Aluminum Association Architectural Class 1 anodized finish.

END OF SECTION 265000

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SECTION 270536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete cable pathway support system as shown and specified including required connectors, supports, brackets, engineered seismic bracing, vertical and/or horizontal offsets, grounding, and hardware for a complete system.
- B. Related Sections
 - 1. 250548 - Mechanical Vibration and Seismic Control
 - 2. 260526 - Grounding and Bonding for Electrical Systems
 - 3. 260529 - Hangers and Supports for Electrical Systems
 - 4. 272010 - Telecom Distribution System
 - 5. 272020 - Telecom Optical Fiber Distribution

1.2 REFERENCES

- A. Underwriters' Laboratories, Inc.
- B. National Electrical Code.
- C. Canadian Standards Association.
- D. ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. ASTM A 123 - Zinc (Hot Dip Galvanized Coatings on Iron and Steel Products.
- F. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
- G. ASTM B 633 - Electrodeposited Coatings of Zinc on Iron and Steel.
- H. ISO 9002.

1.3 SUBMITTALS Provide submittals for products in accordance with Section 260000 - Electrical General Requirements and Division 1.

1.4 SHOP DRAWINGS

- A. Work shall be laid out in advance. Shop Drawings shall be submitted to the Contracting Agency for approval before work begins.
- B. Work under this section has been indicated on the Drawings in locations which should allow installation without interfering with the work of other trades; however, exact finish locations cannot be indicated. Therefore, locations of work and equipment shall be verified to avoid interferences, preserve head room and keep openings and passageways clear. Review the plans for the work of all trades and coordinate adjustment of the work of the trades to achieve the best installation for the Owner without additional claims or charges. Shop Drawings shall reflect coordination of work under this Section.

1.5 QUALITY ASSURANCE

- A. Products shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and bear the UL label.
- B. Alternative systems to the Basis of Design will be considered providing that sufficient documentation is provided to satisfy the Contracting Agency that the equipment meets the requirements of the specification.

PART 2 - PRODUCTS

2.1 FITTINGS

- A. Fittings, inserts, covers, couplings, connectors and other accessories required to for a complete rigid mechanical installation shall be of compatible material.
- B. Cable tray section connectors:
 - 1. Sections of cable tray shall be joined using a two-bolt rectangular splice connector which telescopes into tray spine. Splice connectors shall allow for thermal expansion/contraction of the tray system.
- C. Cable Tray Elbows and Fittings:
 - 1. Provide pre-manufactured elbows and fittings to accomplish changes of direction in cable tray runs, including but not limited to: 30, 45, and 90 degree horizontal elbows, horizontal tees, horizontal crossings, wyes, vertical crossings, wyes and elbows, and inside and outside vertical risers. Fittings shall be of the appropriate type and manufacture for each cable tray type. Minimum inside bending radius (effective cable path) at cable tray elbows and fittings shall be 12 inches.

D. Cable Tray to Box Connector:

1. Provide premanufactured tray to box connector for attachment of cable tray to wall at through wall penetrations (both sides) and for attachment to enclosures. Connectors shall have opening dimensions to match cross sectional area of cable tray, with metal flange on four sides, for attachment to surface of wall or enclosure. Tray shall attach to connector flange via two-bolt rectangular tray section connector which telescopes into tray spine.

2.2 WIRE MESH TYPE CABLE TRAY

- A. Cable tray shall be a continuous, rigid, welded wire mesh cable management system without sharp edges. Wire diameter shall be 0.177 inch (4.5 mm) minimum.
- B. Mesh sections shall have at least one (1) bottom longitudinal wire along entire length.
- C. Nominal Dimensions, unless otherwise shown on the Drawings:
 1. Mesh shall be in a 2 by 4 inch pattern or tighter.
 2. Depth: 4 inches.
 3. Width: 12 inches.
- D. The tray shall be made of electroplated steel wire (AISI 304 or 316L, 2B, finished cold drawn wire)
- E. Wire basket type cable tray shall be UL classified as an equipment grounding conductor. Provide grounding clip for continuous ground of cable management system.
- F. Basis of Design: Cablofil Wire Mesh, Cooper B-Line Flextray, Hubbell NextFrame Wire Basket Tray or as approved.

2.3 J-HOOKS

- A. Where specifically permitted on the Drawings, cables from individual outlets may be run from the conduit stub-out to the cable tray system using j-hooks.
- B. Size J-hooks for 50% spare capacity.
- C. No bridle rings are permitted.

2.4 ACCESSORIES

- A. Dropouts: Provide solid-bottomed cable access dropouts with adequate bend radius where bundles of cables exit the bottom of horizontal cable tray sections.
- B. Grounding and Bonding Strap: Unless otherwise noted on the Drawings, provide braided ground strap to connect discontinuous sections of cable tray, e.g., at through-wall penetrations with tray terminated on each side of wall.

- C. Divider Strip: Provide pre-manufactured divider strip to partition sections of tray as required for separation of systems, or as noted on the Drawings.

2.5 CABLE TRAY SUPPORTS

- A. Center supported cable trays with hangers 12 inches or less in length, measured from the top of the cable tray to the bottom of the structural support shall be supported on maximum 12 foot centers by 1/2 inch threaded rods. Support rods shall pass through a vertical hole in the splice connector or central spine. Each tray support shall be attached by one 1/2 inch nut washer and lock washer on the top and bottom of the spine. Additional supports shall be provided at bends and tee fittings. Factory provided J-hangers, Listed for use with the tray and installed in accordance with manufacturer's instructions may be provided in lieu of through-spine rod hangers.
- B. Center supported cable trays with hangers greater than 12 inches in length, measured from the top of the cable tray to the bottom of the structural support shall be provided with additional bracing as follows:
 - 1. Each support shall be equipped with manufacturer's recommended hanger rod stiffener system.
 - 2. Transverse seismic braces shall be provided at least every 10 feet-0 inches.
 - 3. Longitudinal seismic braces shall be provided at least every 20 feet-0 inches.
 - 4. Seismic supports shall be sized to accommodate the tray being fully loaded with cables.
- C. Seismic supports and bracing shall be in accordance with Section 260529 - Hangers and Supports for Electrical Systems, Section 25 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control and the manufacturer's engineered solution for the project's seismic zone. Where required or recommended by the tray manufacturer, the Contractor shall employ the services of a licensed Structural or Seismic Engineer to design the seismic bracing for the specific seismic zone requirements.
- D. Wall Spacers: Factory provided wall spacers shall be provided between wall mounted cable tray spine and mounting surface to maintain space for rung ends extending through spine. Provide supports at intervals in accordance with manufacturer's requirements.

2.6 FIRE RATED ASSEMBLY PENETRATIONS

- A. Provide permanent fire stop system at all through penetrations of fire rated wall, floor and roof assemblies which meet the evaluation criteria set forth in ASTM Standard E-814 and UL Standard 1479 for fire tests of through penetrations.
- B. Fire stop materials, assemblies and installations shall be approved by Factory Mutual and shall be as published in the latest edition of the Underwriters Laboratories Fire Resistive Directory. Firestop Systems provided shall be acceptable to the Authority Having Jurisdiction.

- C. Penetration seal methods and materials shall have an Underwriters Laboratories fire rating equal to the wall or floor in which the openings are located. The penetration seal must allow future changes, such as addition or removal of cables, with no damage to the integrity of the seal. If the wall or floor penetration is for cable tray passage, the fire stop material shall have been tested by Underwriters Laboratories for use with both galvanized steel and/or aluminum cable tray. The penetration seal shall be unaffected by atmospheric conditions, water exposure, or constant high humidity. The fire seal shall be installed strictly according to the manufacturer/distributor published instruction.
- D. Submit Shop Drawings showing detailed construction of the through penetration firestop system, with reference to the UL Fire Resistance Directory System Number.
- E. Unless otherwise submitted by the Contractor and approved by the Contracting Agency, through wall penetration assemblies shall consist of metallic sleeves inserted into the wall opening with a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or re-install fire-stop materials.
- F. Provide number of pathway devices to accommodate all cables with an additional 15% spare capacity in each device. Provide one entirely spare pathway device, unless otherwise noted.
- G. Equipment: STI EZ Path Fire Rated Pathway, or as approved.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Proceed with the installation only after Shop Drawings are approved by the Contracting Agency. If the Contractor proceeds without approval, relocation as directed by the Contracting Agency shall be at the Contractor's expense.
- B. Install pathways level, straight and true to building lines, unless otherwise noted on Drawings or required due to structural considerations or obstructions.
- C. Cable tray clearances:
 - 1. Maintain 12 inches minimum clearance above top of cable tray. Maintain 3 inches minimum clearance between top surface of ceiling tiles and lowest point on cable tray or cable tray support assembly. Maintain 6 inches minimum clearance to all sides of tray unless tray is placed at a height which requires greater clearance for workers to gain safe, convenient access to tray. Coordinate layout with work of other trades in advance of installation to provide required access with minimum number of offsets in cable tray runs.
- D. If during construction as-built conditions occur, such that cable tray becomes inaccessible for any reason, submit immediately to the Contracting Agency:
 - 1. The type and location of the obstruction, including the trades involved.

2. The means proposed to maintain accessibility.
- E. Install cable tray in an accessible location, visible from the floor, with minimum length hanger rods to avoid cable tray tilting under eccentric loads. If tray tilts at any location, provide 1-1/2 inch pipe in compression over hanger rods, a bar stiffener at hanger rods, or other manufacturer recommended anti-tilt method of mounting tray. Provide stiffener bar at every other support, or in accordance with manufacturer's recommendations.
 - F. Install and support cable tray systems in accordance with span load criteria, assuming 110% of maximum allowable cable-fill regardless of the number of cables installed under this Contract.
 - G. Install cable tray to prevent sharp 90 degree bends in cables in any direction. Rises and drops shall be radiused, tees and crosses shall be flared or have radius fittings at junction points.
 - H. Seismic supports and bracing shall be in accordance with Section 260529 - Hangers and Supports for Electrical Systems, Section 25 0548 – Mechanical Vibration and Seismic Control – Mechanical Vibration and Seismic Control, and the manufacturer's engineered solution for the project's seismic zone.
 - I. Center hung supports and center support tubes shall run full length of the rod to the structure. Tighten rod to place assembly in tension. Center supports suspended by rods shall have sufficient protective tubing over exposed all thread to protect the cable insulation from abrasion.
 - J. Cable tray arranged in vertical configuration for rises and drops shall have standoff support from the wall or structural support surface the facilitate installation of cable support ties. Secure cables in trays with cable ties in accordance with the manufacturer's recommendations.
 - K. Unless otherwise noted on the Drawings or allowed in the Specifications, above ceiling cable tray installations shall meet the following conditions:
 1. Cable trays shall not be installed in inaccessible ceiling areas such as those with lock-in type ceiling tiles.
 2. Cable trays shall not be installed above lay-in type ceilings at a finished height greater than 11 feet above finished floor.
 - L. Unless otherwise noted on the Drawings, install cable tray and accessories to provide electrical continuity throughout system. Provide grounding and bonding straps to maintain electrical continuity at discontinuous connections.
 - M. Follow manufacturer's instructions and details for separation of dissimilar metals including steel suspension rod to aluminum splice connectors or cable tray. Provide nylon bushings at joints, vinyl sleeve at hanger rods.
 - N. Conduit Entries:
 1. Open Cable Tray: Conduits entering open cable trays shall terminate above the tray, within 3 inches laterally and 2 inches vertically of the top of the side rail. Conduits shall be bushed and supported within 6 inches of the termination. Provide a bonding connection from the conduit to the tray system.

2. Enclosed Cable Tray: Conduits entering enclosed industrial cable tray shall be connected to the tray at the vertical center line of either side with an approved conduit connector. Conduit connectors shall be bushed inside the cable tray. Conduits shall be installed and supported in accordance with the NEC and Section 260533 - Raceways and Boxes for Electrical Systems. Conduits shall be installed so as to allow free removal of all sections of the cable tray top cover. Provide a grounding connection from the conduit to the cable tray system.
- O. Coordinate installation of cable tray with cable installers for purposes of symmetric cable loading, supplemental bracing in cases where cable loading will be asymmetric, periodic tie down of cables, and division of tray to maintain required separation of systems.

END OF SECTION 270536

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SECTION 272010 - TELECOM DISTRIBUTION SYSTEM (TDS)

PART 1 - GENERAL

1.1 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide the equipment, materials, and labor to install the systems shown on the Drawings and specified herein. This shall include (but not be limited to) provision of all trenching and backfill, raceways, sleeves, boxes, gutters, shelves, enclosures, shelf and enclosure supports, backboards, equipment racks, line and low voltage wire and cable, patch cords, pull ropes (in unused conduits), terminal modules, panels, outlets, jacks, splices, connections, cable management, labeling, testing and all other material, equipment, and labor required to make the systems fully operational.
- B. The intent of this Specification is to place in working order a complete, fully tested and documented Category 6 system complying with the Codes and Standards referenced herein.

1.2 RELATED SECTIONS

- A. 260533 - Raceway and Boxes for Electrical Systems
- B. 270536 - Cable Trays for Electrical Systems

1.3 COORDINATION

- A. The necessity to coordinate this work with the Serving Utility, Owner and the Contracting Agency is emphasized. The Contractor shall be responsible for any omissions, delays and additional cost due to lack of coordination or approval from the same.
- B. Coordinate work with other contractors and trades. The layout and installation of the systems shown on the Drawings and specified herein shall be coordinated such that all special requirements for telecommunications systems shall be provided and incorporated into the project. The systems to be coordinated shall include (but are not limited to) electrical raceway, grounding, fire rated assembly, lighting, power distribution, control and instrumentation, and labeling of cables, terminations, outlets, jacks, etc. Report all conflicts to the Contracting Agency.

1.4 CODES AND STANDARDS

- A. Where a Nationally Recognized Testing Laboratory (NRTL) listing or classification exists for a product and the product is suitable for the purpose specified and indicated, the product shall bear the appropriate marking indicating the listing or classification.
- B. Where a UL Standard is in effect, equipment shall:
 - 1. Meet that Standard.

2. Bear the UL Label.

1.5 SUBMITTALS

- A. The following shall be submitted in accordance with Section 260000 - Electrical General Requirements and Division 1 in sufficient detail to show full compliance with the specification:
 1. Manufacturer's Catalog Data shall be submitted for the following items. Data shall include a complete list of parts, special tools, and supplies.
 - a. Copper Cable.
 - b. Information Outlets.
 - c. Patch Panels.
 - d. Equipment Racks.
 - e. Terminal Modules.
 - f. Patch Cords and other accessories.
 2. Manufacturer's Installations Instructions.
 3. Labeling System: Coordinate with Contracting Agency for Owner's labeling conventions. Submit Project labeling system for approval.
 4. Contractor qualifications and experience as specified in this Section.
 5. Manufacturer's Warranty as specified elsewhere in this Section, including all warranty provisions and procedures for Owner to follow to obtain warranty service.
 6. Quality Assurance Plan: Contractor shall prepare a quality assurance plan which provides a detailed outline of all testing to be accomplished.
 7. The Quality Assurance Plan shall include, as a minimum:
 - a. A schedule of when tests will be performed relative to installation milestones.
 - b. Specific test procedure that will be used.
 - c. A list of test equipment that will be used including manufacturer, model number, calibration certification, range and resolution accuracy.
 - d. A sample test report form with examples of data to be reported.
 - e. Test plan shall be submitted to the Owner for approval at least 30 days prior to the start of testing.
- B. DELETE SUPERFLUOUS INFORMATION FROM SUBMITTAL DATA, SUCH AS MODEL NUMBERS AND OPTIONS FOR EQUIPMENT CONTAINED ON MANUFACTURER'S DATA SHEETS BUT NOT USED ON THIS PROJECT.
- C. One copy of approved submittals shall be kept at the job site.

1.6 SHOP DRAWINGS

- A. Work shall be laid out in advance. Shop drawings shall be submitted to the Contracting Agency for approval before work begins.
- B. Shop Drawings shall include dimensioned layout of Telecommunications Rooms, including backboards, patch panels, grounding terminal bus bars, ladder racking, equipment, etc. Layouts shall show lighting fixtures, HVAC equipment, etc., which affect room layouts.
- C. Shop Drawings shall include dimensioned layout of major pathways for backbone and horizontal cables, including large conduits (2 inch and larger) and sleeves.
- D. Work under this section has been indicated on the Drawings in locations that should allow installation without interfering with the work of other trades; however, exact finish locations cannot be indicated. Therefore, locations of all work and equipment shall be verified to avoid interferences, preserve headroom and keep openings and passageways clear. Review the plans for the work of the other trades and coordinate adjustment of this work, the work of the other trade or both to achieve the best installation for the Owner without additional claims or charges. Shop Drawings shall reflect coordination of work under this Section with the work of other trades.

1.7 REFERENCE CODES AND STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only, latest edition. The reference codes and standards are minimum requirements.

Reference	Title/Revision
ANSI/ICEA	Publication S-80-576
ANSI/IEEE C2	National Electrical Safety Code
ANSI/NFPA 70	National Electrical Code
ANSI/T1E1.7/92-004R	Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings
ANSI/TIA/EIA-568-D.1	Commercial Building Telecommunication Cabling Standard Part 1: General Requirements
ANSI/TIA/EIA-568-D.2	Commercial Building Telecommunication Cabling Standard Part 2: Balanced Twisted-Pair Cabling Standards
ANSI/TIA/EIA-569-C	Commercial Building Standards for Telecommunications Pathways and Spaces
ANSI/TIA/EIA-571	Environmental Considerations for Telephone Terminals
ANSI/TIA/EIA-606-C	Administration Standard for Commercial Telecommunications Infrastructure
ANSI/TIA/EIA-607-D	Commercial Building Grounding and Bonding Requirements for Telecommunications

Reference	Title/Revision
ANSI/TIA/EIA-854-2001	A Full Duplex Ethernet Specification For 1000mbis/S (1000base-Tx) Operating Over Category 6 Balanced Twisted-Pair Cabling
BELLCORE TR-EOP-000063	Bellcore Network Equipment Building Systems Generic Equipment Requirements
BICSI	Telecommunications Distribution Methods Manual
CFR 47 Part 68	Connection of Terminal Equipment to the Telephone Network
FCC Part 15	Radio Frequency Devices
FCC Part 68	Connection of Terminal Equipment to the Telephone Network
IEEE	LAN Standards: 802.3; 802.4; 802.5; 802.6
IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage Surge Protective Devices
IEEE C62.42	Guide for the Application of Gas Tube Arrester Low-Voltage Surge Protective Devices
IEEE Draft P1250 (D4)	Guide on Service to Equipment Sensitive to Momentary Voltage Disturbances
IEEE Std 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
IEEE Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)
IEEE Std 241	Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
IEEE Std 446	Recommended Practice for Emergency and Stand-by Power Systems for Industrial and Commercial Applications (Orange Book)
NTP 638 - 3031 - 300 STD	Northern Telecom Practice "Bonding and Grounding QCF-Type Bond Clamps Description and Installation"
UL 1283	Electromagnetic Interference Filters
UL 1449	Transient Voltage Surge Protection
UL 1459	Standard for Telephone Equipment
UL 1950	Standard for Information Technology Equipment, Including Electrical Business Equipment
UL 467	Grounding and Bonding Equipment
UL 497	Protectors for Paired Conductors for Communication Circuits
UL 497A	Secondary Protectors for Communication Circuits
UL 497B	Protectors for Data Communication and Fire Alarm Circuits
UL 910	Safety Test for Flame-Propagation and Smoke Density Values for Electrical and Optical- Fiber Cables

1.8 OPERATING CONDITIONS

- A. The electronic equipment designed for office environments and Telecommunications Rooms shall be rated for continuous operation under ambient environment conditions of 10 degrees C (50 degrees F), to 30 degrees C (85 degrees F) and 35 to 65 percent relative humidity, non-condensing.

1.9 QUALITY ASSURANCE

- A. Perform all Work in accordance with all regulatory rules and regulations as well as references in this specification.
- B. Perform all Testing in accordance with ANSI/TIA/EIA-568-D specifications and submit all printed reports.

1.10 QUALIFICATIONS

- A. The telecommunications work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for telecommunications work described in this Section shall be specialty telecommunications contractors, who may be a division of the Divisions 26, 27 and 28 Subcontractor.
- B. Contractor Certification:
 - 1. This subcontractor shall be a certified installer of the cabling system, pre-qualified by the Manufacturer for the purpose of offering the Extended System Warranty as required in this Section.
 - 2. Provide a signed statement indicating that the subcontractor has the ability to provide the service required by the Contract Documents using factory trained and qualified technicians for each major system type and intends to maintain that capability until the end of the guarantee period.
- C. Contractor Experience:
 - 1. Specialty subcontractors bidding telecommunications work shall have a minimum of five years experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
 - 2. Specialty subcontractors shall have completed at least three projects equal or larger in size than this project within the past five years.
 - 3. Submit three experience projects and a list of the tools and test equipment (indicating ownership) expected to be used on this project within 30 days of award to demonstrate experience and access requirements.
 - 4. For each experience project submitted, provide the following information:
 - a. Project name.
 - b. Project location.

- c. Date of completion.
 - d. Owner.
 - e. Owner's representative and phone number.
 - f. Description and dollar value of each installed system.
 - g. Name and specific responsibility of each subcontractor or employee involved with the project.
5. For each experience project submitted, include a brief description of the system types provided and the name of the personnel directly responsible for the design (if required, and to what extent), specification, ordering, installation, programming, testing, demonstration, and overall system coordination for each of the following system types:
 - a. Telecommunications General Requirements.
 - b. Telecommunications Cable Pathway.
 - c. Telecommunications Distribution System.
 - d. Telecommunications Grounding.
 - e. Telecommunications Identification and Labeling.
 - f. Telecommunications Testing.

D. Personnel and Equipment:

1. Specialty subcontractors shall have direct access to all tools and test equipment required to complete the telecommunications work when the work is bid.
2. The specialty subcontractor's project superintendent (in office) and foreman (field) shall have five years' experience at the superintendent and foreman levels, respectively, on completed telecommunications projects of like magnitude and complexity.

1.11 REGULATORY REQUIREMENTS

- A. All Work shall conform to the requirements of NFPA 70 and all local amendments.
- B. All Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

1.12 SPECIAL WARRANTY

- A. The warranty shall extend from the date of Substantial Completion to the longer of twenty (20) years or the length of the Extended Warranty offered by the successful manufacturer.
- B. The warranty shall be extended to the Owner via the manufacturer through a single point of contact and shall be fully backed by the manufacturer.
- C. The Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided consisting of the following:
 1. Extended Product Warranty - The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568-D and ISO/IEC IS 11801-B, exceed the attenuation and NEXT

requirements of ISO/IEC IS 11801-B for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of ISO/IEC IS 11801-B for links/channels. The warranty shall apply to all passive Telecommunication Distribution System (TDS) components.

2. System Assurance - The System Assurance shall cover the failure of the wiring system to support any existing application, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568-D or ISO/IEC IS 11801-B component and link/channel specifications for cabling.
 3. All communications system components shall be rated for end-to-end system Category 6 , or greater performance levels on all pair combinations and warranted to support any existing or future applications which are designed to operate over a 250MHz horizontal channel (as defined in ANSI/TIA/EIA 568-D.2.1), to include support of the following applications. Performance shall be guaranteed under the Special Warranty at 100 meters (328 feet):
 - a. IEEE 802.3 10Base-T, 100Base-TX and 100Base-T4.
 - b. IEEE 802.5 16 Mbps token ring.
 - c. IEEE 802.12 Demand Priority Access Control.
 - d. Asynchronous Transfer Mode (ATM) data transmission at 155 Mbps.
 - e. IEEE 802.3ab 1000Base-T.
 - f. ANSI/TIA/EIA-854-2001 "A Full Duplex Ethernet Specification For 1000mbis/S (1000base-TX) Operating Over Category 6 Balanced Twisted-Pair Cabling".
 - g. Future applications that become certified under the applicable standards as noted above.
 4. Extended Product Warranty - The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).
 - a. In the event this specialty subcontractor is unable to perform, goes out of business or ceases to exist, the manufacturer shall be responsible for identifying a new contractor to assume the warranty work.
 - b. Manufacturers shall bear full responsibility for the work of their certified installer, including all aspects of the design and installation.
 - c. In the event this specialty subcontractor fails to provide satisfactory warranty support, the manufacturer shall be responsible for taking all necessary remedial steps including finding a new contractor to provide warranty work.
 5. System Certification - Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- D. Submit a summary of warranty highlighting major features. Clearly disclose all exceptions to the requirements of this document, and specifically indicate any and all provisions that could potentially void the warranty or reduce its benefit to the Owner.
- E. Warranty programs tentatively approved as meeting the specified warranty are listed below. Final approval is subject to review and approval of the warranty:

1. Berk-Tek/Ortronics Clarity System Warranty.
2. Commscope Systimax Program.
3. Siemon System 6 Warranty.
4. Siemon/Commscope Cabling System Vision Warranty.
5. Commscope (Krone) TrueNet Warranty Program.
6. Ortronics Applications Assurance and Extended Warranty Program (Approved products only).
7. Berk-Tek OASIS Certified Solutions (Approved products only).

1.13 MANUFACTURERS' RECOMMENDATIONS

- A. All installation procedures shall be in accordance with the recommendations of the manufacturer of the material being installed. Printed copies of these recommendations shall be submitted to the Contracting Agency 30 days prior to installation. Installation of the item shall not proceed until the recommendations are received and approved by the Contracting Agency. A copy of the recommendations shall be kept at the job site.

1.14 TERMINOLOGY

- A. "TDS" shall refer to the Telecommunication Distribution System cabling and hardware infrastructure internal and external to a building or buildings used to transmit voice, video and data, etc.
- B. "Stations" shall refer to individual telephone or computers, or remote peripherals of those systems (e.g., printers, facsimile machines, modems, etc.
- C. "Outlets" shall refer to the group of receptacles or jacks at the location where the stations connect.
- D. "Jacks" or "Ports" shall refer to the individual receptacles where phones, computers, etc. connect.
- E. "Station Cables" shall refer to the horizontal cables connecting patch panels or terminal blocks in the Telecommunications Rooms to the stations.
- F. "Pathways" shall refer to conduits, sleeves, cable-trays, distribution rings, etc., which are employed to route backbone and stations cables between equipment rooms, telecommunications rooms, stations, outlets, etc.
- G. "Backbone Cables", "Riser Cables" or "Tie Cables" shall refer to copper cables 25-pair or more and optical fiber cables 6-strand or more, connecting main cross-connect facilities, intermediate cross-connect facilities and telecommunications rooms. These cables may include outside plant cables between buildings and riser cables between floors.

- H. "Equipment Rooms" (ER) or "Communication Equipment Rooms" (CER) shall refer to a special-purpose room that provides space and maintains a suitable operating environment for large communications and/or computer equipment. Main rooms may also be referred to as an MDF.
- I. "Telecommunications Rooms (TR)" shall refer to a floor-serving facility for housing telecommunications equipment, cable terminations and cross-connect wiring. This is the point at which station cables terminate. It may also be referred to as an IDF.
- J. "Terminal Blocks" shall refer to multiple punch down cable terminations.
- K. "Patch Panels" shall refer to rack or frame mounted multiple punch down cable terminations with RJ-45 style, 8P8C jacks on the face for "plug and play" cross connect capability.
- L. "Cable Management" shall refer to rings, troughs, gutters etc., mounted in conjunction with telecommunications distribution equipment and terminal blocks, for the orderly routing of cables, patch cords, etc.
- M. "LEC" shall refer to the Local Exchange Carrier providing telephone service to the facility.

1.15 STORAGE AND HANDLING

- A. Care shall be exercised in handling materials during construction. Damaged materials shall be repaired or replaced as directed by the Contracting Agency.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall be as specified, first quality, manufacturer's current production.
- B. The Basis of Design for copper cabling, connecting hardware, and related hardware in this section is Ortronics hardware with Berk-Tek cable Netclear Warranty as standards for quality and performance. Listed manufacturers meeting all the system quality, performance and warranty requirements of this specification are also acceptable. The burden of proof is on the Contractor to demonstrate that all performance and warranty requirements are met. Any listed manufacturers products submitted without information giving detailed item by item comparison with the Basis of Design will be rejected without review. All manufacturers other than those listed in this section will be rejected without review.
- C. The approved alternate cabling products manufacturers are:
 - 1. CommScope.
 - 2. KRONE.
 - 3. Belden.
- D. The approved alternate connecting hardware products manufacturers are:

1. Commscope
 2. KRONE.
 3. Siemon.
- E. Products shall provide the standard of performance required under paragraph 1.1 and the Special Warranty above.

2.2 EQUIPMENT ROOMS

A. Flooring:

1. For new buildings an anti-static tile floor shall be provided.
2. Material: Vinyl Composition Tile equal to Armstrong SDT.
3. Provide grounding connection to flooring system in two locations, in accordance with manufacturer's instructions. Grounding connections shall be homerun to the TGB or the TMGB using a #6 AWG Green THHN stranded wire.

B. Termination Backboards:

1. Material: Type AC fire retardant plywood. Mount the plywood with the 'A' side exposed.
2. Size: 3/4 inch to cover walls as shown on drawings.
3. Manufacturer: Hoover Pyro-Guard or as approved. Special order may be required to obtain AC grade plywood.
4. Finish: Two coats, flat latex, intumescent fire retardant paint, Flame Control Coatings No. 20-20A, or as approved. Paint plywood on all sides and edges prior to mounting on walls.

2.3 SEISMIC BRACING

- A. Freestanding equipment racks shall be seismically braced in accordance with requirements of the IBC and as required by Section 260529 - Hangers and Supports, of these Specifications. Seismic bracing shall consist of rigid supports. Cables, wires, chains or other non-rigid materials shall not be used for seismic support. Provide approved fixed equipment anchorage assemblies as published by the manufacturer. In lieu of manufacturer's published seismic bracing assemblies, the Contractor shall provide seismic installations approved by a licensed structural engineer.
- B. Approved drawings of seismic assemblies shall be made available for review by the Contracting Agency or the inspecting Authority Having Jurisdiction upon request.
- C. Coordinate the following sections describing equipment racks and cabinets with the fiber specification section (272020 - Telecom Optical Fiber Distribution).

2.4 FREE-STANDING EQUIPMENT RACKS

- A. Where specified, provide full height 19 inch wide NEMA standard open rack frame with the following features.
1. Vertical cable management channels with front mounted cable management rings and top mounted cable trough.
 2. Releasable hook and loop (Velcro™) cable support straps.
 3. Rack assembly shall fit within 24 inches wide by 16.5 inches floor area.
 4. Material and Finish: Steel with black powder-coat painted finish.
 5. Electrically isolated 0.125 inch by 1 inch by 60 inches chassis ground bus bar on the right rear side of the rack, bonded to the chassis with #6 braided by 6 inches long bonding jumpers.
 6. Equipment: Ortronics Mighty MO II, Hubbell NEXT FRAME series racks or as approved.

2.5 RACK MOUNTED POWER DISTRIBUTION/SURGE SUPPRESSION STRIPS

- A. Where specified or shown on drawings, provide rack mounted power distribution strips/surge suppression strips for mounting in the equipment racks furnished. The power distribution/surge suppression strips shall have the following features:
1. 120 volt input and output.
 2. Surge Energy Rating: minimum 480 joules.
 3. EMI/RFI Noise rejection (100kHz to 10 MHz): 70.0 dB.
 4. Guarded master on/off switch preventing accidental switching.
 5. Designed to rack mount in a 19 inch equipment rack.
 6. UL 1449 Listed.
 7. UL 1449 TVSS Rating: 330V.

2.6 CABLE MANAGEMENT

- A. Backboard mounted cable management:
1. Distribution rings installed in communication rooms shall be “D” ring type. No bridle rings are permitted.
 2. Distribution rings shall be sized according the number and size of cables to be supported plus 50 % spare capacity.

3. Vertical trough-type cable management shall be minimum 6 inch wide, cable management trough, 110 Vertical Cable Management trough, or as approved.
4. Horizontal trough-type cable management shall be minimum 3-1/2 inch wide, cable management trough, 110 Horizontal Cable Management trough, or as approved.

B. Rack mounted cable management:

1. Distribution rings shall be sized according the number and size of cables to be supported plus 50 % spare capacity.
2. Distribution rings installed in communication rooms shall be "D" ring type. No bridle rings are permitted.
3. Vertical trough-type cable management for use with standard 7 foot equipment rack, shall be minimum 4 inches deep.
4. Horizontal trough-type cable management shall be 3-1/2 inch wide with horizontal and vertical routing rings, with 2 inches by 1.5 inch cutouts for through cable routing.

2.7 IDC TERMINAL MODULES

- A. Connecting blocks shall match cables punched down under block, i.e., 5-pair for 5-pair color scheme, 4-pair for 4-pair cable, 3-pair for 3-pair cable, etc. When six pair are used 2-3 pair connecting blocks shall be used. For 25-pair or larger, use the 5-pair for 5-pair color scheme. All hardware shall be rated for ANSI/TIA/EIA 568-D Category 6 ratings and installed in accordance with ANSI/TIA/EIA 568-D guidelines. Blocks shall be color coded according to drawings and documented in accordance with ANSI/TIA/EIA 606-C. Blocks shall be identified using clear label holders and labels. Blocks shall be UL Listed.
- B. Insulation Displacement Terminal Modules: Termination blocks shall be modular and scalable up to 500 pair termination assemblies. Provide a retaining trough between every column of termination blocks.
- C. Terminal Modules shall be Type 110 mounting blocks and associated parts and shall support the system Category of the permanent channel hardware installed.
- D. Building entrance protection terminals UL listed, 100 pair building entrance protector modules with 300 to 600 volt solid state protectors in accordance with NEC 800-30 for Fuseless and Fused Protectors.
 1. Protector to have 26 AWG fusible link conductor swivel cable.
 2. Protector shall have 100 Connecting Blocks.
 3. Single pair protectors shall be solid state units.
 4. Fill all modules with protectors.

2.8 PATCH PANELS

- A. Patch Panels: Modular jack panels shall be in 24 or 48 port configurations as shown on the Drawings. Modular jack panels installations shall contain a retaining trough between every panel. Modular Jack Panels shall be wired for T568B configuration.
- B. The terminations shall have the following characteristics:
 - 1. Wire Insulation Supported:
 - a. Size: 0.05 inches Diameter Over Dielectric maximum for top of connecting block
0.07 inches Diameter Over Dielectric maximum for bottom of connecting block
 - b. Types: All plastic insulants (including PVC, irradiated PVC, Polyethylene, Polypropylene, PTFE Polyurethane, Nylon, Teflon)
 - c. Termination Type: Insulation displacement, dry, gas tight
 - 2. Wire Size Supported:
 - a. Solid Wire Ranges: 22-26 AWG, Re-termination >200
 - b. Stranded (7 Strands) Wire Ranges: 22-26 AWG, Re-termination: >200
 - c. Wire Insertion force (24 AWG): 13-28 lb. (59-127 Newtons)
 - d. Wire pullout force (24 AWG): 2.2 lb. (9.7 Newtons)
 - e. Wire retention force (24 AWG): Horizontal 8 lb., Vertical 2 lb.
 - 3. Electrical Specifications:
 - a. Meet or exceed performance defined by ANSI/TIA/EIA-568-D.2, for Category 6 component, link and channel performance.
 - b. UL Listed.
- C. Designation labels for each jack shall be provided for front/rear labeling of each patch panel. All cables shall be terminated in numerical sequence and labeled as to outlet number and jack position (A, B, C, D). Provide color-coded inserts ("icons") for all jacks at patch panels and at each outlet.
- D. Equipment:
 - 1. Category 6: Standard Density Modular Patch Panels.
 - 2. Comply with FCC Part 68.
 - 3. ISO 9001 Certified Manufacturer.
 - 4. Equipment: Ortronics Clarity Category 6 Modular to 110 Patch Panels 110 cross connect system terminal blocks.

2.9 INFORMATION OUTLETS/JACKS

A. Faceplate Requirements:

1. Configure single gang outlet information outlets in single, duplex, triplex, quad-plex, or six-plex jack arrangement, as indicated on the Drawings.
2. Provide outlet faceplates with both top and bottom labeling positions.
3. Provided blank module inserts for all unused module locations.
4. Provide full set of color coded snap-in icons for workstation outlets for use by Owner to mark jacks for analog and digital telephones, two unique classes of data, etc. Store icons in clear plastic bags in each IDF/MDF.
5. Equipment: Refer to Specification Section 262726-Wiring Devices for faceplate type/color.

B. Jack Requirements:

1. Jacks for Voice and Data:
 - a. Communications jacks shall consist of multi-position 8-pin modular (8P8C) jacks, utilizing T568B termination style.
2. Category 6 Jacks:
 - a. Jacks shall be manufactured by the same manufacturer as the modular patch panels.
 - b. All Jacks shall conform to ANSI/TIA/EIA 568-D Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section and shall meet or exceed the following electrical and mechanical specifications:
 - 1). Electrical Specifications: Jacks shall meet or exceed performance specifications for the Channel as defined by ANSI/TIA/EIA-568-D.
 - 2). Mechanical Specifications:
 - a) Plug Insertion Life: 750 insertions.
 - b) Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
 - c) Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
 - 3). Temperature Range: -40° to 150°F (-40° to 66°C).
 - 4). Comply with FCC Part 68.
 - 5). ISO 9001 Certified Manufacturer.
 - 6). Equipment: Ortronics TracJack outlet.

2.10 PATCH CORDS

- A. Provide factory assembled Category 6 Modular Patch Cords for each assigned port on the patch panel. All cords shall conform to the requirements of ANSI/TIA/EIA 568-D Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and the minimum length patch cord shall be provided in each instance, to make an orderly, manageable connection between the patch panels or equipment being cross-connected.
- B. Unless shown otherwise on the Drawings at each location, provide spare Patch Cords of each length and type in each telecommunications room, with blue identified for data and natural for voice patching.

4 foot:	10	each blue and	10	each natural
7 foot:	10	each blue and	10	each natural
10 foot:	10	each blue and	10	each natural
15 foot:	10	each blue and	10	each natural

- C. All patch cords shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pairs.
- D. Patch cords shall be manufactured by the manufacturer of the patch panels and jacks and meet or exceed the Channel performance defined by ANSI/TIA/EIA-568-D.
- E. UL or ETL Verified for ANSI/TIA/EIA 568-D Electrical Performance.
- F. The patch cord shall have exclusion features to prevent accidental polarity reversals and split pairs.
- G. UL Listed for Fire Safety.
- H. ISO 9001 Certified Manufacturer.
- I. FCC Compliant.

2.11 HORIZONTAL CABLES

- A. General:
1. Data cables shall be extended between the station location and its associated TR and shall consist of 4 pair, 24 gauge, UTP, and shall be terminated on the 8 pin modular jacks provided at each outlet. Cable jacket shall comply with Article 800 NEC for use as a plenum. The 4 pair UTP cable shall be UL Listed Type CMP (plenum).
 2. Where conduit is run below slab-on-grade, the cable jacket shall be wet location rated.
 3. Provide cables with four FEP insulated conductor pairs (4/0 configuration)

4. Category 6 UTP, 4 Pair
5. All cables shall conform to the ANSI/TIA/EIA 568-D Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section, and be part of the UL LAN Certification and Follow-up Program.
6. Electrical Specifications:
 - a. DC resistance: $28.6 \Omega/1,000 \text{ ft}$ ($9.38 \Omega/100 \text{ m}$), maximum.
 - b. DC resistance unbalance: 5%, maximum.
 - c. Mutual capacitance @ 1 MHz: maximum pF/ft: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.
 - d. Delay skew: ns/100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.
 - e. Worst pair attenuation, dB/100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.
 - f. NEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.2.
 - g. PSNEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.2.
 - h. ELFEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.2.
 - i. PSELFEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.2.
 - j. Worst Pair Structural Return Loss (SRL), dB at 100m (328 ft.): meet or exceed the performance values specified in ANSI/TIA/EIA-568-D.2.
7. Cables shall meet or exceed Category 6 performance specifications for the Channel as defined by ANSI/TIA/EIA-568-D.2.
8. Environmental:
 - a. Storage temperature: 68° F to 122° F (20° C to 50° C).
 - b. Installation Temperature: 32° F to 122° F (0° C to 50° C).
 - c. Operating Temperature: 14° F to 140° F (-10° C to 60°).
9. UL or ETL Verified for Category 6 Electrical Performance.
10. UL Listed for Fire Safety.
11. ISO 9001 Certified Manufacturer.

2.12 LABELING

- A. Provide machine printed labels for all patch panels, cables, outlets, etc., in accordance with ANSI/TIA/EIA-606-C. Provide labeling nomenclature in accordance with information on the Drawings or Owner's labeling conventions. Submit labeling samples for all required applications.

B. Machine Printed Label Requirements:

1. PC Compatible.
2. Can save and modify files.
3. Fully integrated with AutoCAD.
4. Editable Fonts and Sizes.
5. Rotate Text and Objects.
6. Vary Line Spacing.
7. Ability to import graphical images.
8. Capable for customization of layout.
9. Re-positional labels.

C. Basis of Design:

1. Brady Electrical/Datacomm Worldwide (latest version of LabelMark).
2. Cable Management Software International (latest version of docIT).
3. Approved alternate.

D. Labeling and color coding identification for this project shall conform to TIA/EIA-606-C for a Class 2 Administrative System.

2.13 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional TDS installation shall be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide, connect and test all equipment and materials for the systems herein specified and shown on the Drawings. All wiring shall be neatly tied or laced in cabinets and terminated on terminal strips provided for the purpose. Each cable shall be identified by an approved marking system at each end.

- B. Outlet/Jacks shall be identified with machine printed labels. Hand lettered labels shall not be used.
- C. Provide labels and color-coded inserts for each jack at patch panels, in accordance with TIA/EIA-606-C.
- D. Provide full set of snap-in icons for workstation outlets for use by Owner to mark jacks for analog and digital telephones as two unique classes of data. Store icons in clear plastic bags in each IDF/MDF.
- E. Wherever materials, methods or placements of materials and equipment for the communications work is provided by other Subcontractors or the Owner, it shall be the responsibility of this specialty Subcontractor to coordinate that work and assure that it is provided in such a manner as to enhance the final system operation.
- F. Coordinate installation of lighting, ventilation and all other systems in the communication rooms to avoid interferences.
- G. Test the systems, demonstrate operation to the Contracting Agency and provide training as specified.
- H. In each TR, IC, MDF, IDF and equipment room provide a minimum of a 30 inches by 42 inches CAD drawing indicating floor plan and telecommunication one-line. The floor plan shall indicate telecommunication outlets with the appropriate outlet designation indicated on the plan. Mount drawing beneath a sheet of 1/8 inch clear Plexiglas on wall. Provide marking pens attached with Velcro to facilitate marking when moves, adds, or changes occur. Plexiglass and floor plan shall be mounted in such a way as to allow easy and rapid updates to the underlying floor plan. Include all copper and optical fiber systems on this drawing.
- I. Work under this section shall be closely coordinated with work under other sections of the project.

3.2 CODES AND PERMITS

- A. Apply and pay for all fees, permits, and obtain serving utility and governmental approvals.
- B. Coordinate all work with the serving utility.
- C. Raceway fill requirements for communications systems shall be in accordance with ANSI/TIA/EIA-569-C and BICSI.
- D. NEC bending radius of all communications ducts, raceways, cabletrays, etc., shall be increased to not less than the installed cable manufacturer's recommendations, and the applicable ANSI and BICSI Standards.
- E. Communications work shall be in complete accordance with the following:
 - 1. National Electrical Code (NEC), latest legally enacted edition.
 - 2. Regulations of the State Fire Marshal.

3. National Fire Protection Association (NFPA) Codes.
4. All state, county and local codes and ordinances.

3.3 DELIVERY AND STORAGE

- A. Materials and Equipment shall be stored with protection from mechanical damage, weather, humidity and temperature variation, dirt and dust, and other contaminants.
- B. Materials shall be inspected and inventoried promptly upon receipt.
- C. Cables shall be tested immediately upon receipt and received or rejected and returned based upon testing or visual inspection.
- D. Report and record all serial numbers received and/or rejected.
- E. All inspection and testing shall be performed under the observation of the Contracting Agency at the Contracting Agency's option. Provide three (3) working days advance notice of tests.

3.4 LAYOUT

- A. All work shall be laid out in advance. Shop drawings shall be submitted to the Contracting Agency for approval before work begins. Maximum height for terminal blocks and patch panels shall be 6 feet-6 inches, minimum height shall be 1 foot-6 inches. Cables shall be racked and supported in a workmanlike fashion. All work shall be labeled according to ANSI/TIA/EIA 606-C, and color coded according to BICSI Standards. In the absence of details on the drawing governing the layout of terminations, the following guidelines shall apply.
 1. All horizontal cables from a common outlet shall terminate sequentially (in groups) on the same patch panel unless the cables are of different performance levels such as Category 5e and 6.
 2. Pairs from each cable shall be terminated sequentially from left to right, top to bottom starting with the lowest assigned number at the upper left hand corner of the frame.
 3. Trunk or riser cables shall terminate on dedicated terminal blocks, separate from but adjacent to horizontal terminal blocks. Cross-connect or patch cords longer than 18 feet shall be avoided. Install stress relief hardware where needed.
- B. Keep up to date "As-built" record drawings at each job site detailing the layout of all data racks and telephone, data and trunk terminations, including a typed listing of cables/rooms served by each terminal block and patch panel. Refer to Section 260000 - Electrical General Requirements for other Record Document requirements.
- C. Layout Shop Drawings shall be prepared using CAD. Final approved Shop Drawings shall be updated with precise "as-built" conditions and shall be submitted with the Operations and Maintenance Manuals. File format shall be AutoCAD "DWG" or "DXF."

3.5 CABLE INSTALLATION

- A. If cable dimensions shown are exceeded, all cable pathways and supports shall be resized to maintain the original fill ratios based on the dimensions shown.
- B. Follow cable manufacturer's specification regarding handling methods, retaining/support methods, bending radius and maximum pulling tension limitations.
- C. Telecommunication cables shall not be installed in the same raceway as power cables.
- D. Cables shall be installed in a neat and orderly manner and shall not cross or interlace other cables except at breakout points.
- E. Cables in vertical trays shall be individually retained with straps at a maximum of 6 feet on center.
- F. Tie wraps shall not deform the cable insulation when tightened.
- G. All cables shall be routed to minimize EMI and RFI interference. All cable shall be routed according to the following table. Spacings are minimum for all Category 3 and higher cable.

Minimum Separation of Telecommunications pathways
from 480 volt or less power lines

Condition	<2 kVA	2-5 kVA	>5 kVA
Unshielded power lines or electrical equipment in proximity to telecommunications open or nonmetal pathways.	5 in	12 in	24 in
Unshielded power lines or electrical equipment in proximity to telecommunications grounded metal conduit pathways	2.5 in	6 in	12 in
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a telecommunications grounded metal conduit pathway	N/A	3 in	6 in
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to telecommunications open or nonmetal pathways.	2.5 in	6 in	12 in
Mechanical ductwork, metal floors and other metallic planes to telecommunications open or nonmetal pathways.	2 in		
Mechanical ductwork, metal floors and other metallic planes to telecommunications open or grounded metal conduit pathways.	0 in		

Minimum Separation of Telecommunications pathways from 480 volt or less power lines			
Condition	<2 kVA	2-5 kVA	>5 kVA
Fluorescent or HID lighting fixtures	5 in	5 in	5 in

3.6 LUBRICANT

- A. Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Lubricant shall be applied to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.
- B. Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Soap and grease type lubricants shall not be allowed.
- C. All equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cable shall be pulled without stopping until the required amount of the cable has been placed. When the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be overcome by increasing the tension in small steps a few seconds apart until the cable is in motion. Cable shall be paid from the top of the reel by rotating the reel in the feed direction at the rate of pull. Cable shall not be stripped off the reel by pulling.

3.7 SEAL

- A. Ducts in which cable is placed shall be sealed with urethane foam duct seal. This material shall be inserted between the cable and the duct and in all unused ducts, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

3.8 DAMAGE AND DEFECTS

- A. Adequate care shall be exercised when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

3.9 DISTRIBUTION RINGS AND CABLE SUPPORTS

- A. Mount J-hooks on appropriate mounting hardware suitable for the specific application. Mount securely to the building structure. Maximum support spacing shall be 4 feet on center.
- B. Coordinate the layout of cableways with all other trades. Report conflicts to Contracting Agency for resolution by the Contracting Agency.

3.10 TERMINATION MODULES

- A. Layout telephone and data terminal blocks as indicated on drawings with spacing as recommended by manufacturer.
- B. Ground all metal back frames with #6 insulated copper to the Chassis Ground System (CGS). Use Cool Amp bolted connections or Cadweld connections.

3.11 CROSS-CONNECTIONS

- A. Cross-Connections at and/or between all terminal hardware shall be provided to form a complete and functioning system.
- B. Patch Cords shall be used to make all Cross-Connections.
- C. Cross-Connections from Terminal Modules color coded White to Terminal Modules color coded Blue shall be 4-pair wide and serve a single jack or termination in the horizontal distribution.

3.12 INTERCONNECTIONS

- A. Interconnections at all terminal hardware shall be provided to form a complete and functioning system.
- B. Equipment cables shall be interconnected to horizontal cabling on Termination Modules color coded blue.

3.13 EQUIPMENT RACKS

- A. Equipment racks shall be seismically braced by securely bolting to the structural floor supplemented with additional braces as required for the Seismic Zone.
 - 1. Mount ground bars on insulating bushed standoffs.
 - 2. Connect Wiremold to power outlets.
 - 3. Electrically separate open racks with insulating washers and nonconductive screws.
 - 4. Electrically separate enclosed racks with insulating washers and nonconductive screws.

3.14 TERMINATIONS

- A. Cables shall be marked with wire markers at both ends, and terminals on terminal blocks or patch panels shall bear the cable number. Trunk cables shall be neatly marked with "From-To" information.
- B. Wire twist shall be maintained to within 0.25 inch of the termination.

3.15 TERMINATION MODULES

- A. Install per manufacturer's recommendations.
- B. Protection modules shall conform to NEC 800-30 and be installed per manufacturer's recommendations.

3.16 COMPLETION AND TESTING

- A. Telecommunications System test reports shall be submitted to and approved by the Contracting Agency. The test reports shall certify that the Telecommunications Distribution System is complete, passes all test criteria, is fully operational, and that all work has been witnessed as specified.
- B. After installation and test of each system is complete, each system and the entire system shall be demonstrated and tested for proper operation. The Contractor shall schedule a demonstration with the following representatives present:
 - 1. Contractor's representative.
 - 2. Manufacturer's representative for each major communications subsystem.
 - 3. Contracting Agency's representative.
- C. The Contractor shall provide all forms, instrumentation and test equipment, loads, and other consumables required to demonstrate the systems to the Contracting Agency's satisfaction.
- D. Incoming Inspection Tests:
 - 1. Inspect all materials for damage.
- E. Patch Cord Testing:
 - 1. All patch cords shall be tested and shown to comply with the applicable Category cord requirements of TIA/EIA-568-D.
 - 2. Compliance shall be proven by testing patch cords alone (i.e., not by inserting the patch cords into a channel).
 - 3. Cord performance shall be measured on-site by either using either the TIA method delineated in Annex J or by using a cord-test adapter and a hand-held LAN cable tester. Cord compliance may be demonstrated by actual test reports supplied by the patch cord manufacturer.
- F. Final Inspection Tests:
 - 1. Testing of all copper wiring shall be performed prior to system acceptance. 100 percent of the horizontal and riser wiring pairs shall be tested. Link testing of all copper cabling

shall be performed. Complete, end to end test results shall be submitted to the Contracting Agency.

- a. Category 6 cable runs shall be tested for conformance to the specifications of EIA/TIA 568-D.2, Category 6. Testing shall be done with a ANSI/TIA/EIA 568-D ETL verified Level II-E test set, with accuracy per Proposed TIA Level III standards.
 - 1). Test shall include all requirements of ANSI/TIA/EIA 568-D, including wiremap, length, characteristic impedance, insertion loss, ambient and impulse noise, NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT, return loss, ACR, PSACR, Propagation Delay and Delay Skew.
 - 2). Supported test frequency shall be 1-350 MHz to provide re-certification capability beyond Category 6 requirements.
 - 3). "Full Plot" storage shall store entire test, and be capable of uploading saved data and re-characterizing cables against new or evolving performance standards. Testers only saving worst case data are not acceptable. Test data shall be saved and provided to the Owner in neatly bound hardcopy and electronic format compatible with ScopeData Pro® software. Provide a copy of the software with the data.
 - 4). Reports shall be graphic, showing test results plotted against standards. Reports shall include a pass/fail summary of all network types specified.
 - 5). Any cables not meeting the requirements of the standard shall be brought into compliance at no charge to the Owner.
 - 6). Tester shall be equal to Agilent Technologies (HP) WireScope 350, Fluke DSP-4000, or IDEAL LANTEK 6P.
2. Test all cable with an approved cable tester in the presence of the Contracting Agency, at the Contracting Agency's option. Provide three (3) working days advance notice of tests. Record cable numbers on data test reports. Submit reports to Contracting Agency.
3. Test all cables from both ends.
4. Re-test all cable disturbed after testing, at the direction of Contracting Agency.
5. Spare unterminated cable shall be temporarily terminated for testing.
- G. Replace all rejected materials.
- H. Test AC grounds and voltages in equipment racks.
 1. Record voltage at equipment rack power source both at no load and at 15 Amp resistive load.

3.17 OPERATING AND MAINTENANCE MANUALS

- A. Prepare manuals describing the servicing and maintenance requirements for the equipment being provided as required in this Section of these specifications.
- B. Information contained in the manuals shall consist of catalog data on each item, together with parts lists, wiring diagrams, test reports, description of routine maintenance required,

suggested frequency of maintenance and recommended practices, and shall be 8-1/2 inches by 11 inches in size. Catalog pages and data in manuals shall be neat, clean copies. Drawings shall be accordion folded to above size. An index shall be provided which shall list all contents in an orderly manner. Include corrected shop drawings in the maintenance manuals. Each copy of the instruction manual shall be adequately labeled for identification and shall include plastic tabs coordinated with the index.

- C. Provide "Step-by-step" instructions for interpreting and utilizing the cable, outlet, jack and equipment identification system, including instruction for use of jack icons.
- D. Refer to "Submittals" requirements of this Section for additional O&M requirements.

3.18 INSTRUCTION AND TRAINING

- A. Provide factory trained and authorized instruction in the proper operation and maintenance of all equipment shown on the Drawings and specified herein.
- B. Provide detailed instructions to the Owner on how to obtain warranty service under the Special Warranty.

END OF SECTION 272010

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281333 - SECURITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The intent of this Specification is to place in working order a complete, fully tested and documented integrated Security Management System (SMS) complying with the Codes and Standards referenced herein.
- B. The Security Management System outlined in this section and detailed in Part 2 of this document is the key central component for managing physical security and the bridge between physical and logical security for this project. The system shall provide a variety of integral functions including the ability to regulate access and egress; provide identification credentials; monitor, track and interface alarms.

1.2 CODES AND STANDARDS

- A. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards:
 - 1. UL 294, "Access Control System Units"
 - 2. UL 1076, "Proprietary Burglar Alarm Units and Systems"
 - 3. FCC – Part 15 "Radio Frequency Devices"
 - 4. FCC – Part 68 "Connection of Terminal Equipment to the Telephone Network"
 - 5. NFPA 70, NEC
- B. Where more than one code or regulation is applicable, the more stringent shall apply.

1.3 SUBMITTALS

- A. Provide Submittals for all products in accordance with Section 260000 - Electrical General Requirements and Division 1. Submittals shall include the following:
 - 1. Product Data: Provide complete product data that includes the following:
 - a. Manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the SMS.
 - b. A system description including analysis and calculations used in sizing equipment required by the SMS. The description shall show how the equipment will operate as

a system to meet the performance requirements of the SMS. The following information shall be supplied as a minimum:

- 1). Server(s) processor(s), disk space and memory size
 - 2). Description of site equipment and its configuration
 - 3). Network bandwidth, latency and reliability requirements
 - 4). Backup/archive system size and configuration
 - 5). Start up operations
 - 6). System expansion capability and method of implementation
 - 7). System power requirements and UPS sizing
 - 8). Device / component environmental requirements (cooling and or heating parameters)
 - 9). A description of the operating system and application software.
2. Shop Drawings
 3. O&M Manuals: The manuals shall consist of the following:
 - a. Hardware Manual
 - b. Software Manual
 - c. Operators Manual
 - d. Maintenance Manual
 4. As-Built Drawings

1.4 QUALITY CONTROL

A. Manufacturer Qualifications

1. The manufacturer of the SMS shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.
2. SMS Manufacturer shall employ at a minimum the following methods for QA of component and assembly devices.
 - a. Visual inspection of devices shall be performed to verify assembly according to defined procedures.
 - b. End of line operational tests shall be performed to ensure product functionality has been correctly configured.
 - c. A system burn-in period shall be utilized to screen for early life failures of electronic components.
3. Individual functionality and system level regression testing shall be performed to ensure compliance with product specifications. Single and multiple unit system tests shall be performed to mimic end-user installation configurations. Automated hardware and software testing shall be utilized to evaluate system performance under published operational loads and shall be compared to published system capabilities.

B. Bidder Qualifications

1. At the time of the bid, the bidder shall have satisfactorily completed projects similar in size, scope and complexity as the system detailed in this specification and on the drawings. The bidder shall furnish written proof of experience from three (3) references and proof of current accreditation/certification by the manufacturer for required training for sales/installation/service of the SMS and associated devices.
2. The bidder shall also be a factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for the SMS and related systems under this contract.

1.5 WARRANTY

A. SMS Software and Field Hardware Warranty

1. SMS Software and Hardware shall be warranted for a period of one (1) year from the date of Substantial Completion, be free of defects, and will function in accordance to this Specification. This one (1) year warranty shall include any third party devices and device warranties necessary or required to make a fully functional system as specified herein and as shown on the drawings. Third party devices include (but are not necessarily limited to) devices that are directly interconnected to the SMS field hardware or computers and are purchased directly from the SMS manufacturer. Examples may include; Reader Heads, Biometric Devices, Computers, etc.

B. Installation Warranty

1. CONTRACTOR shall warrant all SMS equipment and labor for a period of one (1) year from date of Final Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. SMS Software

1. The Security Management System software shall be manufactured by Lenel Systems International

B. SMS Field Hardware

1. Lenel Intelligent System Controllers (ISC)
2. Lenel Intelligent Single Door Controller (ISDC)
3. Lenel Intelligent Dual Reader Controller (IDRC)
4. Lenel Single Reader Interface Module (SRI)

5. Lenel Dual Reader Interface Module (DRI)
6. Lenel Input Control Modules (ICM)
7. Lenel Output Control Modules (OCM)
8. Lenel ancillary devices as required

C. SMS Authentication Hardware

1. HID iClass, 13.56 MHz contactless Smart Card – Model R40
2. HID iClass, 13.56 MHz contactless Smart Card with Integral Keypad where called for on the Drawings – Model RK40
3. HID iClass, 13.56 MHz contactless Smart Card where space prohibits use of HID R40 or as directed by the Contracting Agency on a specific case by case basis - Model R15 or R10.
 - a. These are some other compatible authentication hardware options, use HID iClass as default unless something else is requested.

2.2 SMS SERVERS AND WORKSTATIONS

A. Security Management System Server

1. The SMS Server shall be 100% IBM Personal Computer Standard compatible, approved for use with Microsoft Windows 2016 Server and Microsoft Windows 10 Professional, and scaled according to the following system application requirements:
 - a. SMS Server shall consist of Dell PowerEdge R6415 or equivalent rack mountable server with the following salient features:
 - 1). 32 Core, 64-bit, AMD EPYC processor
 - 2). 16 GB ECC DDR-4 SDRAM
 - 3). 1 TB, SSD, NVMe, M.2 boot drive
 - 4). 4 TB storage drive
 - 5). 1 GB/sec Ethernet Port
 - 6). 10 GB/sec Ethernet Port
 - 7). 21" SVGA Flat Monitor (1920 x 1080)
 - 8). Integral Video Card
 - 9). Rack mounted 1500 VA UPS
 - 10). 3 year limited warranty

B. Security Management System Alarm Monitor/Client Workstation

1. The SMS Client Workstation(s) shall be 100% IBM Personal Computer Standard compatible, approved for use with Microsoft Windows Server 2016 and Microsoft Windows 10 Professional, and scaled according to the following system application requirements:

- a. SMS Client Workstation shall consist of a Dell XPS 8930 or equivalent desktop computer with the following salient features:
 - 1). 8 core, 8 thread, 64-bit, Intel i7-9700K processor
 - 2). 16 GB DDR-4 SDRAM
 - 3). 256 GB, SSD, NVMe, M.2 boot drive
 - 4). 1 TB storage drive
 - 5). 1 GB/sec Ethernet Port
 - 6). 21" SVGA Flat Monitor (1920 x 1080)
 - 7). NVIDIA GeForce RTX 2060 6GB, GDDR6 video card
 - 8). 1500 VA tower UPS

2.3 SMS FIELD HARDWARE

A. Intelligent System Controller (ISC)

1. The ISC shall be capable of communicating to the host computer in a single or dual-path configuration of Ethernet, dial-up or direct connect RS-485 communication. The ISC shall be capable of being configured with multiple combinations of Input Control Modules, Output Control Modules and Card Reader Interface Modules (up to 64 devices) using the two downstream RS-485 2-wire ports.
2. The ISC is required to continue to function normally (stand-alone) in the event that it loses communication with the SMS software. While in this off-line state, the ISC shall make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be stored in local memory, and then uploaded automatically to the SMS database after communication has been restored.
3. In addition, the ISC shall incorporate the following features:
 - a. On-board high-speed Ethernet 10/100Base-T.
 - b. Host dual path communication enabled - on-board Ethernet TCP/IP, direct wire (RS-485, 2-wire multidrop capable), or dial-up communications
 - c. 15 MB of available on-board, non-volatile flash memory
 - d. Battery-backed, non-volatile storage of 50,000 events
 - e. Firmware stored in flash memory, background download of firmware updates supported
 - f. 12 or 24 VDC input power
 - g. Up to 32,000 access level permissions
 - h. UL-294 listed and CE approved

4. Acceptable manufacturer/model: Lenel LNL-3300

B. Intelligent Single Door Controller (ISDC)

1. The Intelligent Single Door Controller (ISDC) shall interface one or two readers to a single access door. The ISDC shall be an Ethernet ready card reader panel that controls a single opening with 802.3af compliant Power over Ethernet (PoE).
2. The ISDC shall function independently of the host and be capable of sophisticated processes while controlling access for a single opening. Without host intervention, the

ISDC shall be able to relate selected system devices and their activity to other onboard devices.

3. In addition the ISDC shall incorporate the following features:
 - a. Primary Port: 10/100 Ethernet
 - b. Two reader ports: Magnetic stripe, Wiegand, or RS-485 (RS-485 on one reader port capable of supporting two readers)
 - c. Two fixed inputs for door contact and request to exit (REX)
 - d. Two outputs; one dedicated for a strike and one general purpose (Form C, 2A @ 30Vdc)
 - e. 6 MB of available on-board, non-volatile flash memory
 - f. Firmware stored in flash memory, background download of firmware updates supported
 - g. 240,000 cardholders, 50,000 event transaction buffer
 - h. Up to 128 Access Levels per cardholder
 - i. UL-294 listed and CE approved
4. Acceptable manufacturer/model: Lenel LNL-2210

C. Intelligent Dual Reader Controller (IDRC)

1. The Intelligent Dual Reader Controller (IDRC) shall interface one or two doors to an OnGuard system. Additional I/O and reader interface modules shall be able to be added on the IDRC's downstream port.
2. The IDRC shall be capable of storing up to 250,000 cardholders in non-volatile flash memory, and support selective download for larger cardholder databases. The IDRC shall be capable of connecting to up to 32 devices (maximum 64 doors) using the downstream RS-485 two-wire port.
3. In addition the IDRC shall incorporate the following features:
 - a. On-board Ethernet 10/100Base-T port. DHCP and fixed IP addressing supported.
 - b. 6 MB of available on-board, non-volatile flash memory
 - c. Battery-backed, non-volatile storage of 50,000 events
 - d. Up to 32,000 access level permissions
 - e. 12 or 24 VDC input power
 - f. 4 Form-C relay outputs, 5 A at 30 VDC
 - g. Door contact supervision (open/closed) and REX push-button monitor for each door
 - h. On-board regulator to allow 12 VDC reader power from 24 VDC power source
 - i. UL 294 and 1076 listed and CE approved
4. Acceptable manufacturer/model: Lenel LNL-2220

D. Single Reader Interface Module (SRI)

1. The SRI shall provide a link between the Intelligent System Controller (ISC) and the card reader attached to the interface. Each SRI module shall be individually addressed.
2. In addition the SRI shall incorporate the following features:

- a. 12 or 24 VDC power supply
 - b. Two Form-C relay outputs (5 A door strike and 1 A aux)
 - c. Up to 16 different card formats (8 card formats and 8 asset formats)
 - d. Door contact open or closed, supervised or non-supervised
 - e. REX push-button monitor - supervised or non-supervised
 - f. Support for offline reader access mode
 - g. UL 294 and 1076 listed and CE approved
3. Acceptable manufacturer/model: Lenel LNL-1300

E. Dual Reader Interface Module (DRI)

1. The DRI shall provide a link between the Intelligent System Controller (ISC) and the card reader attached to the interface. The DRI shall include eight inputs that support normally open, normally closed, supervised, and non-supervised circuits. In addition, six output relays shall support fail-safe or fail-secure operation.
2. In addition the DRI shall incorporate the following features:
 - a. 12 or 24 VDC power supply
 - b. Six Form-C 5 A at 30 VDC relay outputs
 - c. Up to 16 different formats (8 card formats and 8 asset formats)
 - d. Dedicated tamper and power failure circuits
 - e. Support for offline reader access mode
 - f. On-board regulator allows 12 VDC reader support from 24 VDC power source
 - g. UL 294 and 1076 listed and CE approved
3. Acceptable manufacturer/model: Lenel LNL-1320

F. Input Control Module (ICM)

1. The Input Control Module shall communicate directly with the Intelligent System Controller (ISC) and provide 16 configurable input control points and 2 output control relays. It shall support normally open, normally closed, supervised and non-supervised circuits. The output relays shall be capable of being configured for fail-safe or fail-secure operation.
2. In addition, the ICM shall incorporate the following features:
 - a. Grade B, A, and AA line supervision
 - b. 12 or 24 VDC input power
 - c. 16 programmable supervised or non-supervised contacts
 - d. 2 Form-C 5 A, 30 VDC contacts for load switching
 - e. 2 dedicated inputs for tamper and power failure status
 - f. RS-485 communication (2-wire or 4-wire RS-485)
 - g. UL 294 and 1076 listed and CE approved
3. Acceptable manufacturer/model: Lenel LNL-1100

G. Output Control Module (OCM)

1. The Output Control Module shall communicate directly with the Intelligent System Controller (ISC) and provide 16 relay contacts for load switching. The relays shall be configurable for fail-safe or fail-secure operation.
2. In addition, the OCM shall incorporate the following features:
 - a. 16 Form-C 5 A, 30 VDC contacts for load switching
 - b. 12 or 24 VDC input power
 - c. 2 dedicated digital inputs for tamper and power failure status
 - d. RS-485 communication, multidropped (2-wire or 4-wire RS-485)
 - e. Up to 16 OCMs per Intelligent System Controller
 - f. UL 294 and 1076 listed, CE approved
3. Acceptable manufacturer/model: Lenel LNL-1100

H. Local Alarm Horn

1. Provide a horn at each access controlled portal requiring one as noted on the drawings.
 - a. Devices shall activate upon door alarm condition creating an audio indication of door alarm.
 - b. Devices shall be silenced remotely via the SMS or upon return of the portal to a secure state.
 - c. Upon acknowledgement of the alarm by the SMS operator the device shall reset.
2. Horn indicator shall be low profile and shall be supplied with all mounting hardware.
 - a. The CONTRACTOR shall determine correct type of mount and back box for each horn device location.
3. Acceptable manufacturer/model: Cooper Wheelock Model MT-12/24, no substitutions.

2.4 SMS SOFTWARE

- A. The SMS shall utilize a single seamlessly integrated relational database for all functions utilizing a fully multi-tasking multi-threading Microsoft Windows 7 or Windows Server 2008 Operating System.
- B. Upgrades or expansion of the SMS to a larger size system in scale shall not require installation of a different and/or new SMS application or require the administrator or operator to learn a different and or new interface from the previous version.
- C. The SMS shall be Microsoft Windows 7 Certified and shall have passed Microsoft-designed tests for compatibility and reliability on Windows 7.
- D. The SMS shall be UL 1076 Listed.
- E. The SMS shall only require a single license key to be present on the database server for the SMS to operate. The license key shall either be a physical device or a software license key.

- F. The SMS shall support concurrent licensing with respect to client licenses. Department shall purchase a fixed number of client workstation licenses (or connections) that shall be programmed into the database server license file. The SMS shall be installed on any number of client workstations in the facility. Then, any of the client workstations that have the SMS software installed shall have the ability to connect to the database server as long as the maximum number of concurrent connections purchased has not been reached. Connections shall be licensed on a per module basis. This shall provide Department with great flexibility in system design and layout.
- G. The SMS shall be able to seamlessly interface with and monitor intelligent system controllers, reader interface modules, I/O panels, alarm panels, alarm panel receivers, biometric devices, personal protection devices, intercom systems, fire alarm panels (secondary monitoring only), building management systems and digital video recorders approved for use by the SMS manufacturer.
- H. The SMS shall be able to communicate with intelligent system controllers via RS-485, RS-232, TCP/IP or Ethernet, and dialup via modem.
- I. The SMS shall utilize an open architecture where all data must reside on a single database and must be accessible in real time to SMS workstation or Web-based client connected to the network. The system shall be configurable to support all of the following databases: Microsoft SQL Server 2008, Microsoft SQL Server 2005, Oracle Server 11g, and Oracle Server 10g. Oracle data may reside on Windows or UNIX platforms.
- J. The system architecture shall support Microsoft Windows Clustering, Hot Standby, Fault Tolerant Servers and Fault Tolerant Hot Standby Servers.
- K. Acceptable manufacturer/version(s): Lenel OnGuard 32ES

2.5 SECURITY MANAGEMENT SYSTEM GRAPHICAL USER INTERFACE

- A. The SMS shall be configured with a Graphical User Interface (GUI) as specified herein which minimizes training and operational needs for the operators. The software shall include on-line help displays to eliminate operator reference manuals. The GUI shall be an integral part of the SMS and is what SMS operators will use to interface with the SMS.
 - 1. The GUI shall represent each floor of the building separately.
 - 2. The GUI shall operate such that if the Access Control System goes into alarm due to a door forced or door held open, the GUI will flash or highlight a border around that location.
 - 3. Coordinate design of GUI base maps with the Owner prior to final deployment and commissioning of system

2.6 INTRUSION DETECTION SYSTEM (IDS)

- A. The IDS specified herein shall include a Digital Alarm Communicator Transmitter (DACT), built-in telephone line monitor, up to 1000 event memory logger, real time clock, calendar, test timer, battery charging / voltage supervision circuitry, battery lead supervision, diagnostics displays, time / event-based scheduling system, lightning / EMI protection circuits, and the associated optional modules and components for a complete IDS.
- B. The DACT firmware shall support programmable "software" features as detailed below. The following describes the general functional requirements of the IDS:
 - 1. The IDS shall support the connection and reporting of intrusion devices to a remote Digital Alarm Communicator Receiver (DACR).
 - 2. The IDS shall provide identification, annunciation, and communication of alarmed detectors by point.
 - 3. The IDS shall be capable of segregating the points (i.e., a detector or group of detectors zoned together) into separate, independent "areas."
 - 4. The IDS shall be "modularly" expandable using hard-wired address identification modules.
 - 5. The IDS shall have electrically supervised detection loops and power supplies (mains and battery(s)). This supervision shall be programmable for the purposes of reporting this information to the DACR.
 - 6. The IDS shall be capable of monitoring and switching to active telephone lines when trying to establish communications with the DACR and transmitting a report.
 - 7. The IDS shall be capable of reporting and communicating alarm or trouble event data by reporting to off-site remote DACRs via dial-up analog telephone lines or over a local or wide area network using a network interface module.
 - 8. The IDS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
 - 9. The IDS shall be programmable locally or remotely. Programming shall be accomplished via a portable programmer or a computer running the Remote Programming Software (RPS). Users shall be capable of changing their own user passcode from the Alarm Command Center (ACC) and managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
 - 10. The IDS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English text at the ACC.
 - 11. The IDS shall be capable of executing diagnostics and testing functions locally or remotely.
 - 12. The IDS shall be capable of activating 128 relays and three additional outputs for auxiliary functions based on its classifications (area vs. panel wide).

13. The IDS shall be capable of controlling relays and automatically executing system functions based on a time / event scheduling program. The program can be hour, day of week or day of month based. Each scheduled event can be exclusive of one of four holiday date definitions that can include one to 365 selected Julian dates. The following functions can be executed:
 - a. Arm / Disarm a specific area
 - b. Bypass / Unbypass a point
 - c. Activate / Deactivate a relay
 - d. Send a test report
 - e. Adjust system clock for daylight savings time

C. System Feature/Capability Summary

1. The following indicates system software/hardware capabilities, capacities, and formats:
 - a. Number of Loops/Sensors: 246 separately identifiable points, of which 8 are on-board loops and 238 are off-board addressable points / zones connected to multiplexed backbone trunks. Each of the points shall be capable of supporting "group zoning." Group zoning refers to the combining of sensors into a separately identifiable and separately annunciated (programmable text) area.
 - b. Programming Point Functionality: Each point in the system shall provide for the following type of response in the system.
 - 1). Always on (24 hour response)
 - 2). On when the system is Master Armed
 - 3). Only on when the system is Perimeter Armed
 - 4). Displays / Does Not Display at the ACC when the point is activated
 - 5). Provides / Does Not Provide entry warning tone
 - 6). Sounds / Does Not Sound audible alarm indication
 - 7). The Point is bypassable / not bypassable
 - 8). Alarm Verification with programmable verification time
 - 9). Relay activation by Point
 - 10). Provides / Does Not Provide "watch point" capability
 - 11). Provides Swinger Bypass
 - 12). Defers Bypass Report
 - 13). Can return to the system after being force armed and then restoring
 - 14). Can return to the system after being bypassed and then restoring
 - c. Areas/Accounts: The IDS shall support 8 independent areas. Each of the eight (8) areas shall have custom text associated with the armed state, disarmed state and point-off-normal state. Additionally, the IDS shall be capable of assigning 1 to 8 account identifiers to the areas depending on the distribution of areas per account. Each and all of the eight areas must be capable of Master and/or Perimeter arming (excluding predefined Interior protection).
 - d. The IDS shall be capable of logically grouping 2 or more points into an area, or conversely, dividing the points into two or more areas.
 - e. Any area shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
 - f. Areas shall be independently controlled by their corresponding ACC. Each ACC can be designated to control a specific area, or group of areas, or all areas in the system.

- g. Independent control or relay functions by area shall be possible through programming assignments.
- h. Number of Alarm Command Centers: 32 Unsupervised ACCs, each capable of displaying custom English text on vacuum fluorescent displays and sounding different patterns of audible alarm for different events, shall be required. Up to Eight (8) ACCs can be supervised at one time. An ACC can be programmed to respond to the entry of any of the specifically authorized 250 user passcodes (followed by the [ENT] key) and cycle an assigned access control door using a connected door controller. The event is logged and transmitted (if routing is ON) to the DACR including door and user identity.
- i. Number of User Passcodes: Up to 249 different passcodes shall be required. Each passcode shall be three (3) to six (6) digits (variable) and be assigned a 16-character user name that shall be printed on the local printer and DACR with associated opening and closing reports from the user. Passcodes shall be enabled or disabled by area(s) and shall be assigned one of fourteen (14) different authority levels to carry out functions such as the activation of relays from the ACC. These passcodes shall also be required for carrying various system functions such as arming the system, disarming the system, transmitting a duress code, resetting the system and silencing sounders. A single user passcode shall be able to be used in each of the 8 areas with potentially a different authority level in each area.
- j. Each of the 249 different passcodes shall be able to be associated with 4 individual access cards/tokens. The authority of any of the four cards assigned to the user will be that of the user, but each card will report in the display, local printer, memory event log and at the DACR as a separate user / subuser number pair.
- k. Communication Formats: The Radionics Modem IIIa² communications format shall be utilized for optimum system performance. The DACT shall report to a Commercial Central Station using a Bosch Security Systems D6500 or D6600 Alarm Receiver that supports the Radionics Modem IIIa² communications format. One such advantage is point identification information transmission to DACRs (Alarms, Troubles and Restorals by point). Others include actual point number; point text; actual user number, user name; by-passed points; relay activation; opening/closing reports by users; late, early, or fail opening/closing reports, and opening/closing reports by area.
- l. Testing, Diagnostic, and Programming Facilities: Automatic test reports and remote system access for diagnostics, programming, and log (Logger) uploads shall also be supported via a remote central station computer utilizing the RPS software.
- m. Logger Capacities and Formats: Up to 1000 events indicating time, date, type of event, account number, area number, user ID, point text, user text and primary/secondary event route each event. Logs shall be viewed locally at the ACC and remotely via an upload to a computer running the RPS software. The IDS shall also support the printing of these events on up to three local printers. The IDS shall also send a report to the DACR when the log reaches a programmable "percent full capacity" so that RPS can retrieve the stored events. Group, signal type and area can route events to specific printers.
- n. Reports: Reports to DACRs at commercial central stations as a result of system supervision shall include alarm, trouble, missing modules, restoral, system status, AC failure and low battery. The IDS shall also transmit test reports once every 24 hours. CPU failure shall be annunciated locally. The ACCs should display the following information for the indicated system supervisory conditions:
 - 1). Call for Service
 - 2). Service Panel

- 3). Service Param
 - 4). Service AC Fail
 - 5). Service Battery Low
 - 6). Service Battery Missing
 - 7). Service Communications Failure
 - 8). Service Keypad
 - 9). Service Route
 - 10). Service Printer
 - 11). Service Point Buss Failure
- o. Telephone Lines, IP Addresses, and "Phone Routing": The IDS shall support one (1) or two (2) telephone lines that are to be alternated for the transmission of consecutive events. The IDS shall have the capability of communicating with up to eight (8) different DACRs (4 different phone numbers) and/or four (4) different IP Addresses. Each Phone Number can be up to 24 digits long. The IDS reports shall be classified, by event, into eleven (11) subcategories or "report groups." Each group represents similar types of events. Individual events within each group shall be selectively enabled or disabled to be transmitted. Each DACR shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destination for the event. The transmission of events allows the reporting of different types of information to different remote DACRs. The report groups shall be as follows:
- 1). Burglar Reports
 - 2). User Reports
 - 3). Test Reports
 - 4). Diagnostic Reports
 - 5). Relay Reports
 - 6). Auto Function Reports
 - 7). RAM (RPS) Reports
 - 8). Point Reports
 - 9). User Change Reports
- p. Number of Programmable Relay Output Modules: 8 relays (Form C) are to be provided per octo-relay module for a total of 128 relays plus three additional outputs per IDS. These multi-purpose modules are programmable and shall be used to implement auxiliary functions (manually or automatically).
- q. Relays and other outputs may be programmed to follow up to 14 different area conditions or up to 12 panel conditions. Relays may also be programmed to follow individual points or groups of points.
- r. Number and Alarm Output Selections: Four (4) different types of alarm output selections shall be supported by the IDS: Steady, Pulsed, California Standard, and Temporal Code 3.
- s. The system can be configured to provide zoned indication of alarm conditions.
- t. Miscellaneous Features: Programmable alarm output timer, 31 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, and keyswitch arming capability with LED outputs.
- u. Real-Time Clock, Calendar, and Test Timer: The IDS shall incorporate an integral real-time clock, calendar, and a test timer.
- v. Opening and Closing Windows: The system shall be programmed with "normal" opening and closing periods for each day of the week and thus suppress scheduled opening / closing reports and report only the exceptions, i.e., opening / closing

- outside the pre-defined time window. The IDS shall have the capability to suppress opening / closing reports, overriding the programmed open / close windows during holidays and automatically arming the IDS (by area) at the end of the closing period.
- w. IDS Power Ratings: The IDS shall provide 1.4 amps of auxiliary power and 2 amps of alarm power, both rated at 12 VDC.
 - x. IDS Fault Detection: The IDS shall check the point sensor loops once every 300 milliseconds. The point response time is programmable over a range of 300 milliseconds to 4.5 seconds.
 - y. User-Programmable Features: The IDS shall provide a menu driven interface to provide a user-friendly command structure for programming / customizing the system to the operational criteria of the application. The IDS shall be capable of being operated via:
 - 1). The Command Structure
 - 2). Menu / Command List
 - z. Shall be able to connect up to three parallel printers (D7412G) to the DACTS.

D. IDS SYSTEM INTERFACE REQUIREMENTS

1. Grounding: The CONTRACTOR shall properly earth ground the IDS to prevent electrostatic charges and other transient electrical surges from damaging the IDS panel.
2. Primary power: The CONTRACTOR shall provide a dedicated 120 VAC power circuit to the IDS system. This circuit shall be connected to the emergency power system. The 120 VAC is stepped down to 16.5 VAC to power the IDS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.
3. Primary power supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 to 12 hour transmission delay. The message can also be programmed to "tag-along" with another message transmitted to the central station. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
4. Secondary power (standby battery): Provide adequate battery power as defined by the relevant application criteria, (UL 864 and 985 for alarm installations or NFPA 72 chapters for fire applications). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable MOA codes or MOA requirements must be met accordingly.
5. Secondary power supervision: When the secondary power source experiences a 85% depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.
6. Wiring: The CONTRACTOR shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:

- a. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
 - b. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
 - c. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
 - d. Where EMI may interfere with the proper operation of the IDS circuits, twisted/shielded cable shall be used.
7. The IDS shall be protected from EMI and lightning surges.
 8. Telephone interface: The IDS shall be equipped with a phone line monitor and shall interface with the phone lines via RJ-45 jacks for supervision of the telephone line connection to the IDS panel. When a telephone line is determined to be out of service by the IDS panel, the event will be annunciated locally on the ACC and transmitted to the central station. The transmission delay of this message is programmable from ten (10) to two-hundred forty (240) seconds. A telephone line switching modules shall be used to interface to a second telephone line. This interface shall conform with FCC rules part 15 and 68.
 9. Ethernet access: The IDS may use an Ethernet interface module as the primary means of communicating to a DACR. Up to four IP Addresses shall be available to route system events to. A programmable supervision time of 5 to 65,535 seconds shall be required.
 10. Auxiliary function control interfaces: Auxiliary functions such as activating bells, strobes, or lights shall be accomplished using the optional relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damages.
 11. Functional criteria programmed into system memory shall be backed up by battery power. Additionally, the number of system programmers shall be severely restricted via the use of program locking features and passwords.

E. EQUIPMENT AND MATERIALS

1. System Hardware Description:
 - a. IDS: The IDS shall be provided, at minimum, with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
 - 1). Enclosure
 - 2). Lock and key
 - 3). D9412G DACT with removable terminal blocks and single screw mounting bracket
 - 4). Faceplate shield and metal bracket covering rear of D9412G circuit assembly
 - 5). Power transformer
 - 6). Manuals
2. The IDS control panel shall be Bosch Security Systems model D7412G.
 - a. System Accessories:

- 1). -D125B-Class "B" loop module - Dual Powered loop interface module - two separate powered loops for 12 or 24 VDC, 2-wire devices
 - 2). -D130-Relay module 5 amps, Form C
 - 3). -D279A-Sub Zone Control
 - 4). -D55-Desk Stand
 - 5). -D56-Alarm Command Center surface conduit backbox
 - 6). -D8103-Universal enclosure
 - 7). -D811-Arm status relay module. Form C relay, activated based on information transmitted on the serial output
 - 8). -D8121A-Subscriber Terminal Unit (STU) - Works with Base Ten Telecom, Inc. VerSuS[®] derived-channel receiving system to provide alarm and critical event reporting as well as telephone line supervision
 - 9). -D8122-UL-listed version of D8121A
 - 10). -D8130-UL release module – designed for release applications commonly found in NFPA 72, chapter 6, fire alarm installations such as fire door release, elevator recall, emergency door unlock, stairwell pressurization, smoke exhaust control and HVAC control. Two independent Form C contacts, each rated at 5 amps. Multiple D8130s can be connected in parallel to a DACT.
 - 11). -D9002-5-Accessory Module Mounting Skirt
 - 12). -D9131A-Parallel Printer Interface Module – provides Centronics standard parallel output to be used for a parallel printer. 80 character format.
 - 13). -D9133-Serial Interface Module
 - 14). -D9133DC-Direct Connect Programming Module
 - 15). -D9133TTL-E-Network Interface Module – provides connection to local or wide area networks to communicate system events to D6600 NetCom Receiver.
 - 16). -D9412G-D9412G circuit board mounted on steel mounting skirt and literature pack
 - 17). -DS150i-Request to Exit Detector
 - 18). -DS7432-Eight Input Remote Module (MX2040)
 - 19). -DS7450-Flush Mount Single Multiplex Contact Point
 - 20). -DS7452-Surface Mount Single Multiplex Contact Point
 - 21). -DS7457-Single Multiplex Input Module (MX2010 Intrusion)
 - 22). -DS7460-Dual Input MUX Module (MX2020)
 - 23). -DS7465-Input/Output Module (MX4010)
- b. Power Supply:
- 1). -D122-Dual battery harness
 - 2). -D8004-UL transformer enclosure
 - 3). -D8132-UL - 12 V auxiliary battery charger. Combined with external batteries, increases standby time and provides additional power to auxiliary outputs of D9412GB.
- c. Communication Accessories:
- 1). -D162-2 ft. (61 cm) phone cord
 - 2). -D166-RJ-31X Phone Jack
 - 3). -D928-Dual telephone line module – Alternates event transmission to Central Station between primary and secondary phone lines. Transmits over other phone line when first phone line is determined to be inoperable. Periodically tests phone line for usage and integrity and reports to central station when phone line is faulty. Remembers faulty line and transmits over operational line.
 - 4). -D9133TTL-E-Ethernet Interface Module

- d. Annunciation Devices:
 - 1). -D1255-Alarm Command Center (ACC) - Built-in multi-tone sounder. Displays status in custom English text on 16-character display. If more than 4 ACCs are required, add D8132 battery charger unit. ACCs provide "command menu" user interface. ACC can be supervised. Model D1255R for red color, D1255W for white.
- e. Programming
 - 1). -D5500C-XXXX-LTE-Remote Programming Software, Limited Programming Modules (RPS-Lite)
- 3. Initiating Devices
 - a. Acoustic Glass break Sensors:
 - 1). Sentrol #5812NT "ShatterPro 3" UL listed acoustic glass break sensor with 360° coverage pattern, adjustable 25-foot maximum coverage radius, Form A contacts, 12VDC input, and 2.75" x 4" rectangular white ABS housing designed to install on a single-gang box.
 - b. Motion Sensor
 - 1). GE Mirror Optic 360 Degree Dual Ceiling Mount, Model AP669 - UL Listed ceiling Mount PIR with From C relay, 8 foot - 16 foot mounting height.
 - c. Balanced Magnetic Switch (Door Contact)
 - 1). Balanced magnetic type switches signals door position.
 - 2). Device shall consist of two units mounted adjacent to each other in door and frame.
 - a) Switch unit: Doorframe mounted containing magnetic switch.
 - b) Magnet unit: Door mounted, containing permanent magnet.
 - 3). Acceptable manufacturer; Sentrol 2767 High Security or approved equal.
 - 4). Acceptable manufacturer for surface mount on fire rated wood doors - Securitron model number MSS-1G-RT or approved equal.
- 4. Intrusion Detection System (IDS) Test Equipment
 - a. Glass break Sensor Tester
 - 1). Product Description: Hand-held tester that generates glass break sounds to test glass break sensors.
- 5. Manufacturer: GE Model #5709C-W or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment and materials in accordance with the recommendations of the manufacturer. The work shall also be in accordance with:
 - 1. Installation criteria defined in these specifications and in the Bid Documents.

2. Approved Submittals.
 3. Applicable requirements of referenced standards.
- B. Install card readers where shown on the drawings.
- C. Locate controllers in accessible locations approved by the Department.

3.2 DOOR HARDWARE AND DOOR OPERATION

- A. Program the SMS system specified herein to implement the door (SMS access portal) Sequence of Operations as specified in Specification Section 08 71 00 for each particular door with SMS hardware specified as shown on the drawings or as detailed in that Specification. Refer to Specification Section 08 71 00 and the drawings for more specific requirements.

3.3 TESTING

- A. Upon completion of the system installation, the CONTRACTOR shall notify the Department a minimum of 72 hours in advance, and functional testing shall be planned.
- B. The CONTRACTOR shall furnish all personnel, equipment, tools, software, means of communications, test instrumentation, and supplies necessary to perform all testing.
- C. The testing shall demonstrate the following:
1. That the system in its entirety meets all requirements of the Contract Documents.
 2. That system equipment meets all requirements of the Contract Documents.
 3. That all system functions and operations meet all requirements of the Contract Documents.
- D. Each field-mounted device shall be tested via actual activation of the device under normal operating conditions rather than simulated activation.
- E. Where system testing will cause outages or impacts, schedule testing activities so as to impose the least inconvenience on system users. This may require that the CONTRACTOR schedule testing off shift in order to avoid conflicts with operations.
- F. All system and subsystems functionality and system integration and interfaces shall be 100 percent tested.

3.4 ADJUSTMENT, CORRECTION, AND COMPLETION

- A. Make necessary adjustments and modification to the system.
- B. Correct deficiencies and retest affected components.

- C. If, during testing, the system fails to achieve the required standard for acceptance, the Contractor shall resubmit the system for testing after taking such remedial steps as necessary to correct the deficiency.

3.5 SYSTEM ACCEPTANCE

- A. System acceptance shall occur at the time of approval of the functional testing as determined by the Department. The warranty period shall begin from that date.

3.6 DEMONSTRATIONS AND TRAINING

- A. Each of the intended operations of the installed SMS shall be demonstrated to the Department by the Contractor.
- B. After the system provided in this Section is completely installed and operational, and at a time chosen by the Department, provide the Department's system operators and maintenance personnel with a total of eight (8) hours of instruction on the operation, maintenance, and troubleshooting of all equipment provided under this Section.
- C. Training sessions shall be presented by a fully qualified, trained representative of the equipment manufacturer, who is thoroughly knowledgeable on the specific installation. Separate sessions shall be given for operation personnel and maintenance personnel, with the length and content of the sessions tailored to the respective groups.
- D. Provide an additional two (2) hours of follow-up instruction for review and clarification at a later time mutually agreed on with the Department, if the Department deems it necessary.

END OF SECTION 281333

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SECTION 282310 - IP CLOSED CIRCUIT TELEVISION

PART 1 - GENERAL

1.1 DESCRIPTION AND GENERAL SPECIFICATIONS

- A. Provide the equipment, materials, and labor to install the systems shown on the Drawings and specified herein. This shall include (but not be limited to) provision of all cameras, server(s), storage arrays, software, programming, raceways, wire, cable, cabinets, boxes, line and low voltage wire and cable, patch cords, terminal modules, panels, outlets, jacks, connections, cable management, labeling, testing and all other material, equipment, and labor required to make the systems fully operational.
- B. The intent of this Specification is to place in working order a complete, fully tested and documented CCTV System and Network Video Recording System for viewing, recording, and retention of CCTV video. The CCTV System and Network Video Recording System shall comply with the Codes and Standards referenced herein and with the manufacturer's installation instructions and requirements.

1.2 DEFINITIONS

- A. Contractor: Within this section of the specifications, "Contractor" shall mean the Security Contractor performing this portion of the work.
- B. Provide: Within this section of the specifications, "provide" shall mean to furnish and install.
- C. NVRS – Network Video Recording System
- D. RU – Rack Unit (1-3/4 inches of rack or cabinet space)
- E. IPTV – Internet Protocol Surveillance System

1.3 PROJECT SUMMARY

- A. The project consists of the installation of a Network Video Recording System (NVRS) in the Yakutat Community Health Clinic in Yakutat, Alaska. Provide the system hardware, a fully licensed Standard Edition of the Avigilon Video Management (ACC) and Client stations including installation of any software on the server(s) or clients provided in accordance with these Specifications.
- B. The NVRS shall be a network video solution, utilizing a standard IP-based network infrastructure to transport and record digitized video signals from security cameras. The system will allow authorized users to view live and recorded video either locally within the building or remotely through a web interface. The NVRS shall have built in video analytics for Appearance search of person and motion search by object type either vehicle or person.

- C. IP cameras shall be used to capture the live video images of the areas under surveillance and shall stream digitized video signals over Category 6 cable to Ethernet network switches in the Main Telecom Room.
- D. The system shall be capable of monitoring both live and recorded video on authorized PC workstations using the Avigilon Video Management System Standard Edition client software.
- E. Connect the cameras, telecom horizontal cables, patch cords, Ethernet network switches, the Network Video Recording System (NVRs) Server to form a complete and physically separate Network Video Recording System network on dedicated fiber optic cable backbone provided for this purpose in accordance with Specification Section 272020 and the Drawings.
- F. The project includes installation of video surveillance equipment, the structured cabling system infrastructure transport, a grounding and bonding system, and electrical equipment to support the system.

1.4 WORK INCLUDED

- A. The Contractor shall furnish all labor, equipment, wiring, supplies, materials, and programming necessary for the installation of a complete and operational Network Video Recording System in accordance with these Specifications, the drawings, and the terms and conditions of the Contract, except as specifically noted otherwise. Contractor shall be responsible to provide all system programming, test and checkout, and training for the work specified herein and detailed on the drawings.
- B. The work of this section shall include, but not be limited to furnishing and installing the following:
 - 1. Indoor, Fixed Digital (IP) Color Cameras
 - 2. Outdoor Fixed Digital (IP) Lowlight Color Cameras
 - 3. Varifocal Lens
 - 4. Camera Housings
 - 5. Camera Mounts
 - 6. Video Management Software (installation of ACC Avigilon Video Management System Standard Edition)
 - 7. Video Management Client Stations for viewing live and retrieval of video and management of cameras.
 - 8. NVRs Network PoE+ switches
 - 9. Provide Category 6 UTP patch cords for interconnecting Category 6 horizontal cables to cameras in accordance with Specification Section 272010 Telecom Distribution System.
 - 10. Provide Category 6 UTP patch cords used interconnecting Category 6 horizontal cables at telecom patch panels to the Ethernet network switches and Network Video Recording

System Server in accordance with Specification Section 272010 Telcom Distribution System.

11. Electrical boxes and raceways at device locations and equipment cabinets as necessary for mounting devices and interconnecting equipment
12. Firestopping pathways that penetrate fire-rate walls, floors, and ceilings.
13. All ancillary materials, including cable, wire and connectors necessary to provide a complete and operational system
14. Grounding and bonding of installed equipment

1.5 RELATED SECTIONS

- A. 017900 - Demonstrations and Training
- B. 019100 - Commissioning
- C. 272010 - Telecom Distribution System
- D. 283100 - Addressable Fire Alarm System

1.6 REFERENCES

- A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section.
- B. H.264/MPEG-4 Part 10 Video Compression Standard
- C. M-JPEG 10 Video Compression Standard
- D. IEEE 802.3ab Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Gigabit Ethernet Network
- E. IEEE 802.3af Power-over-Ethernet (PoE) Standard
- F. IEEE 802.3g Wireless LAN Standard
- G. IEEE 802.1Q VLAN Trunking Protocol
- H. IEEE 802.1 Quality of Service (QoS)
- I. ASTM E-814 Fire Tests of Through-Penetration Fire Stops.
- J. UL 1479 Fire Tests of Through-Penetration Firestop.
- K. 2008 NFPA 70 - National Electrical Code (NEC).

1.7 COORDINATION

- A. Coordinate the work of this section with the Contracting Agency as required to ensure that the entire work of this project will be carried out in an orderly, complete and coordinated fashion.
- B. Supply all necessary supervision and coordination of information to any contractor or subcontractor who is performing work to accommodate the work of this section and minimize interferences.
- C. Coordinate the exact mounting location and Field of Views (FOV) for each camera with the Contracting Agency prior to installation.
- D. The locations of NVRS and CCTV equipment are diagrammatically expressed on the drawings. Exact locations of items of work shall be field coordinated. Report major discrepancies between locations of devices on the drawings and within the field to the Contracting Agency within three days.

1.8 INTENT OF DRAWINGS

- A. The drawings are diagrammatic unless detailed dimensions are included. Drawings show close approximate locations of equipment and devices. Exact locations are subject to the approval of the Contracting Agency.
- B. In case of differences between the specifications and drawings, the stricter provision, as determined by the Contracting Agency, shall govern. Omissions from the drawings or specifications, or the incorrect description of details of work which are evidently necessary to carry out the intent of the drawings and specifications, shall not relieve the Contractor from performing such work.

1.9 SUBMITTALS

- A. Product Data and Shop Drawings
 - 1. Submittals shall include product data literature and shop drawings. Submittals shall include adequate descriptive literature, catalog cut sheets, shop drawings and other data necessary for the Contracting Agency to ascertain that the proposed equipment and materials comply with specification requirements.
 - 2. Product data submittals shall consist of catalog cut sheets, technical data sheets, manufacturer specifications, brochures and/or diagrams necessary to illustrate a product, material or system for some portion of the work. Product data literature is required on all items of material and equipment and should be clearly marked, identifying specific items proposed.
 - 3. Shop drawings shall include floor plans showing the exact locations of cameras and detailed elevation views of layouts within the Main Telecom Room showing equipment cabinets. All shop drawings shall be created using AutoCAD, version 2015 minimum.

4. Prior to assembling or installing the work, prepare and submit shop drawings and product data literature for review and approval by the Contracting Agency.

B. Calculations

1. Bandwidth Calculations: Provide bandwidth calculations for the digital cameras using the frame rates, resolution and video compression standards specified and submit to the Contracting Agency for review and approval prior to construction. These bandwidth calculations will be used to verify that the specified backbone cable and related infrastructure will meet the required needs of the system.
2. Pixel on Target review shall take place per camera location to insure the correct clarity of recording and live viewing.
3. Recording Storage Calculations: Provide recording storage calculations for the system using the total number of digital cameras, frame rates, resolution and video compression standards specified and submit to the Contracting Agency for review and approval prior to construction. These storage calculations will be used to verify that the specified storage will meet the minimum required storage retention time as specified below.

- C. The Contractor shall not purchase any materials or equipment prior to receipt of appropriately reviewed and approved Submittals from the Contracting Agency.

- D. Review of product data shall not relieve the Contractor from responsibility for deviations from the drawings or specifications, unless the Contractor has, in writing, called attention to such deviations at the time of submission and secured written approval.

- E. The Contractor shall develop and submit complete Submittals and do so in a timely manner. By failing to do so, the Contractor agrees to be fully responsible for any and all damages which might be incurred by the Contractor's failure to do so.

- F. Submittals shall include four (4) copies of Product Data Submittals and Shop Drawings.

- G. Product Data Submittals and Shop Drawings shall be submitted forty (45) days from the date of notice to proceed.

- H. Quality Assurance/Control Submittals:

1. Pre-functional Installation (PC) and Functional Performance Test (FT) Checklists in accordance with Section 019100 – Commissioning.

1.10 REGULATORY REQUIREMENTS

- A. All Work shall conform to the requirements of NFPA 70 and all local amendments.

- B. All Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

1.11 QUALITY ASSURANCE

- A. All equipment shall meet or exceed the minimum requirements of NEMA, ASME, ANSI and Underwriters Laboratories.
- B. All material and equipment furnished shall be new and unused and free from defects. Equipment shall be clean and free of damage or corrosion, and shall be of the best quality obtainable for the purpose intended.
- C. Any specified item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item are not permitted, unless specifically noted otherwise and approved in writing by the Contracting Agency.
- D. System hardware and software components shall be produced by a manufacturer regularly engaged in the production of Closed Circuit Television Systems and Network Video Recording System equipment for a minimum period of 5 years.
- E. Perform all Work in accordance with all regulatory rules and regulations as well as references in this specification.

1.12 CONTRACTOR QUALIFICATIONS

- A. The Network Video Recording System (NVRs) work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for the work described in this Section shall be specialty contractors, who may be a division of the Divisions 26, 27 and 28 Subcontractor.
- B. The installing Contractor shall be a company specializing in the design, installation, and testing of electronic security systems and specifically CCTV and Avigilon NVRs systems.
- C. The installing Contractor shall have a minimum of three years of experience in this specialized field and shall have completed a minimum of three projects similar in scope to this project.
- D. All Work shall be performed by qualified individuals having at least three (3) years experience installing and/or maintaining CCTV and NVRs systems. The qualified individuals shall have completed installation of at least two (2) systems of 25 cameras or more within the past five (5) years. Submit evidence of successful installation, Contracting Agency training and maintenance for a minimum of the previous five years. Provide listing of projects with verifiable references with names and telephone numbers. Qualified individuals shall be Avigilon factory trained for the systems being provided as part of this Contract. Submit evidence of successful factory training no later than 30 days from Notice to Proceed.

1.13 WARRANTY

- A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship shall be replaced or repaired as directed by the Contracting Agency for the duration of the stipulated guarantee period.

- B. The Contractor shall warrant all labor, workmanship, and materials provided under this Contract for a minimum period of 1 year from date of Substantial Completion or as specified elsewhere in these specifications.
- C. If items supplied as part of this project have longer warranties, the Contractor shall match the longer warranty duration from the date of Substantial Completion.
- D. If other individual Specification Sections require longer warranty, the Contractor shall match the longer warranty duration from the date of Substantial Completion.
- E. The Contractor shall guarantee in writing all phases of the work against defective materials and workmanship. Should a failure occur within the warranty period, the Contractor shall provide all labor and materials necessary to restore the system to its' full and operating condition at no cost to the Contracting Agency.

1.14 MAINTENANCE AND SERVICE

- A. General Requirements: Provide services and equipment necessary to maintain the entire NVRS system in an operational state as specified for a period of 1 year after Substantial Completion of the system. Provide all necessary material required for performing scheduled maintenance or other nonscheduled work.
- B. Response Times: For the warranty period the following response times shall be maintained:
 - 1. The initial call to the Contractor shall require the type of call to be classified as critical or non-critical. The nature of the problem and the effect on school operations will be the deciding factor in classifying the problem. For the purpose of defining the priority of the call, the Contractor shall have personnel accessible to YCHC personnel via phone call-back within one (1) hour of initial call.
 - a. Non-critical Items: These are defined as failures or problems that do not affect the overall safety, security, or operation of the school.
 - b. Critical Items: These are defined as failures or problems that do effect the overall safety, security, or operation of the school. The failure of a primary server would be an example of a critical item requiring immediate remedy.
 - 2. Non-critical items: The Contractor shall diagnose and remedy the problem during normal working hours arriving on site the earliest standard transportation allows. The initial response shall be the morning of the next day if received before noon or by the noon the next day if received before close of business. Normal business hours are defined as 8 AM to 4 PM Monday through Friday.
 - 3. Critical Items: Critical items require the Contractor to respond in an expedition manner. The Contractor shall be on-site the earliest standard transportation allows. These calls will possibly need to be responded to outside of normal business hours.
- C. If the Contractor fails to respond to the service request within the specified time, the YHC will have the right to repair the system without invalidating the warranty. In the event the Contracting Agency affects repairs because of Contractor non-response, the Contractor will be charged for the repair cost.

- D. Software Upgrades: Contractor shall install any updates to the manufacturer's software for the NVRs equipment throughout and up to the end of the warranty period at no cost to the Contracting Agency.

1.15 TRAINING

- A. Provide on-site training by a qualified, factory-trained instructor for designated operation personnel and maintenance technicians on the operation and maintenance of the system. If trained personnel from the factory are required for training, they shall be provided on-site by the Contractor at no additional cost to the Contracting Agency.
- B. Provide the following training upon completion of final testing and acceptance of the system:
 - 1. Demonstrate operation of system in all modes of operation.
 - 2. Provide minimum of 2 hours of system maintenance training to designated personnel. Classes shall accommodate up to five (5) students at one time.
 - 3. Maintenance training shall cover all operations and technical training required for maintenance, preventative maintenance and system adds, moves and changes including detailed instructions on system software modifications.
 - 4. Provide minimum of 4 hours of operator training to system operators. Classes shall accommodate up to five (5) students at one time.
 - 5. Provide course syllabus for all training courses in advance of each course, with an outline of the topics, time allotted for each topic, targeted audience and training objectives. Submit training manuals to the Contracting Agency for review and approval a minimum of ten (10) working days in advance of scheduled training. Training shall not commence until training syllabus has been approved.
 - 6. Provide a sheet accompanying any training that includes basic system terminology and definitions.
 - 7. All training materials shall be of professional industry standard quality and provided in both hard and soft copy.

1.16 RECORD DOCUMENTATION

- A. Record documentation shall include:
 - 1. Operation and Maintenance (O&M) Manuals. (Hard and soft copy)
 - 2. Complete set of record as-built shop drawings. (Hard and soft copy)
 - 3. Complete test reports. (Hard and soft copy)
 - 4. Installed camera serial numbers (Hard and soft copy)
 - 5. Installed NVR serial numbers (Hard and soft copy)

6. Installed network switch(es) serial numbers (Hard and soft copy)
- B. Operation and Maintenance (O&M) Manuals.
1. Upon completion of the project, submit a complete set of product data sheets for all products installed. Product data sheets shall be clearly marked, identifying the specific items installed.
 2. Where applicable, submit operations manuals and maintenance manuals for active and passive components of the installed systems.
 3. Submit four (4) identical sets of O&M Manuals.
- C. See Section 019100 – Commissioning for product and O&M manual submittal sequencing.
- D. Record Drawings
1. Maintain a complete set of contract drawings. Use this set of drawings for showing as constructed installation of systems and equipment. Plans shall include, but not be limited to, showing exact location and heights of devices, and appropriate identification. Detail drawings shall show exact locations of equipment racks, cross-connects, and any other pertinent details.
 2. Where any material, equipment, wiring or system components are installed differently from that shown, show such differences clearly and neatly.
 3. This set of drawings shall be kept up to date as the job progresses and shall be made available for inspection by the Contracting Agency at all times.
 4. Upon completion of the project, incorporate this set of drawings with as constructed details into the Shop Drawings using AutoCAD, version 2015. Submit four (4) full-size sets of drawings and the AutoCAD drawing files on DVD to the Contracting Agency
- E. Test Reports
1. The Contractor shall be responsible for recording all test data. Copies of all test results are to be submitted for review by the Contracting Agency as part of final acceptance and subsequently submitted to the Contracting Agency for their records.
 2. Submit test reports in both printed format and an electronic format to assist the Contracting Agency in the final review process. Printed test reports shall be provided in 8-1/2" x 11" three ring binders. Electronic copies of the test reports shall be in a pdf format.
 3. Refer to the testing section of the specifications for details on the data that shall be included in the test reports.
 4. Submit one (1) printed copy of the test reports and three (3) electronic copies of the test reports on separate DVDs to the Contracting Agency.

1.17 NETWORK VIDEO RECORDING SYSTEM SCOPE OF WORK

A. System Architecture

1. The Network Video Recording System shall be a network video solution, utilizing a standard IP-based network infrastructure to transport and record digitized video signals from security cameras. The system will allow authorized users to view live and recorded video either locally within the building or remotely over a web interface using the Avigilon ACC Video Management System client software.
2. Provide IP cameras at the locations shown on the drawings to capture live video images of the areas under surveillance.

B. Video Recording

1. The digitized video signals transported from the IP cameras over the network shall be stored and recorded on a NVRS server located within the Main Telecom Room.
2. Digitized video signals shall be recorded on the NVRS server for retrieval at a later date as required. Retention time of the stored digital images shall be a minimum of 30 days before being written over at a frame rate of 8 frames per second for cameras provided under this Contract.
3. Obtain the Avigilon ACC Video Management System Standard Edition software and install on the NVRS server for managing the live, recorded, and stored NVRS video.

C. Monitoring and Control

1. The system shall provide monitoring of both live and recorded video on authorized PC workstations, using the Security Access System's client software.
2. The system shall also be capable of monitoring both live and recorded video on authorized remote workstations. The system shall be capable of transmitting digital video signals from the local archive server or directly from IP cameras from the SMS/NVRS dedicated Ethernet LAN and allow remote viewing of live images via the optional web interface.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Protect all materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain. If items are damaged, do not install, but take immediate steps to obtain replacement.
- B. Acceptable Manufacturers and Substitutions
 1. Named manufacturers are the basis of design for this system.

2. The Contractor may submit a request for approval of equal products or materials. The request shall include product literature and a complete compliance checklist with individual specification paragraph performance requirements. The request shall be submitted to the Contracting Agency for review and possible approval within the specified time before the bid.
3. No requests for substitutions shall be considered after the bid opening.

2.2 INDOOR FIXED IP CAMERA (TYPE A)

A. General

1. Camera shall be IP based and fully integrated and managed through a system software package.
2. Camera shall feature a built-in automatic unusual scene digital motion detector with alarm output.
3. Lightcatcher technology for low light scenes.
4. Camera shall have accessible USB port to use of a WiFi dongle for quick set up only.
5. Minimum Specifications:
 - a. Compression: H.264 and Motion JPEG
 - b. Resolution: 2046x1536 pixels. = 3.0 Megapixels
 - c. Frames Per Second:
 - 1). 20 fps in all resolutions
 - d. Image Sensor: 1/2.8" Progressive scan RGB CMOS
 - e. Lens: F1.4 varifocal 3-19mm, motorized varifocal
 - f. Dynamic Range not less than 100db
 - g. PoE compliant: 802.3af
 - h. Mounting: Ceiling/wall/Pendant mounted dome enclosure
 - i. Enclosure: dome
 - j. Shall have HDSM IP Stream Management
 - k. Power: Power over Ethernet (PoE) from Ethernet network switches
 - l. Connectors: Ethernet 10BaseT/100BaseTX, RJ-45, Mini DC power jack, Terminal block for 1 alarm input and 1 output, 3.5 mm jack for Mic or line mono input, 3.5 mm jack for line mono output to active speaker.
 - m. Camera required to be manufactured in the U.S.A
6. Acceptable Manufacturers
 - a. Avigilon: Model 3.0C-H4SL-D1 or approved equal for indoor locations.

2.3 OUTDOOR FIXED BULLET IP CAMERA (TYPE B)

A. General

1. Camera shall be IP based and fully integrated and managed through a system software package.
2. Camera shall feature a built-in automatic unusual scene digital motion detector with alarm output.
3. Lightcatcher technology for low light scenes.
4. Camera shall have accessible USB port to use of a WiFi dongle for quick set up only.
5. Minimum Specifications:
 - a. Compression: H.264 and Motion JPEG
 - b. Resolution: 2046x1536 pixels. = 3.0 Megapixels
 - c. Frames Per Second:
 - 1). 20 fps in all resolutions
 - d. Image Sensor: 1/2.8" Progressive scan RGB CMOS
 - e. Lens: F1.4 varifocal 3-19mm, motorized varifocal
 - f. Dynamic Range not less than 100db
 - g. PoE compliant: 802.3af
 - h. Mounting: Surface mounted Bullet style enclosure
 - i. Enclosure: dome
 - j. Shall have HDSM IP Stream Management
 - k. Power: Power over Ethernet (PoE) from Ethernet network switches
 - l. Connectors: Ethernet 10BaseT/100BaseTX, RJ-45, Mini DC power jack, Terminal block for 1 alarm input and 1 output, 3.5 mm jack for Mic or line mono input, 3.5 mm jack for line mono output to active speaker.
 - m. Camera required to be manufactured in the U.S.A
6. Acceptable Manufacturers
 - a. Avigilon: Model 3.0C-H4SL-BO1-IR or approved equal for outdoor locations.

2.4 CAMERA MOUNTING EQUIPMENT

A. General

1. Exterior cameras to be mounted in one of three manners: Wall and ceiling soffit mount or Pole.
2. Acceptable Manufacturers
 - a. Avigilon or approved equal.

2.5 CCTV CAMERA WIRING

- A. Interior cameras: Provide one telecommunication horizontal cable to each camera in accordance with Specification Section 272010 Telecom Distribution System.
- B. Exterior cameras: Provide one telecommunication horizontal cable to each camera in accordance with Specification Section 272010 Telecom Distribution System.

2.6 CATEGORY 6 PATCH CABLES

- A. Provide in accordance with Specification Section 272010 Telecom Distribution System.

2.7 NETWORK VIDEO RECORDING SYSTEM SOFTWARE

- A. General
 - 1. Provide a fully licensed version of Standard Edition of the ACC Avigilon Video Management System software for operation of this Network Video Management System.

2.8 ETHERNET NETWORK SWITCHES

- A. Provide layer three switches at interior locations as shown on the Contract Drawings. Equip each switch with two 1000Base-LX/LH GBIC adapters. Configure all switch settings as follows:

2.9 NVRS SERVER

- A. General
 - 1. The NVRS server will be the device to store all recorded CCTV digital video images from all cameras.
 - 2. The server shall be Microsoft Windows 10 IoT Standard LTSB based and shall control all data flow.
 - 3. The server processor shall be an Intel Xeon processor.
 - 4. The CCTV Archive Server shall have the following characteristics:
 - a. Operating Software: Microsoft Windows 10 IoT Standard LTSB
 - 1). CPU: Intel i9-9900, 8 physical cores with Hyper threading
 - 2). RAM: 32 GB DDR4 RAM
 - 3). 512 GB SSD NVMe, M.2 boot drive
 - 4). 4 Terabytes storage drive
 - 5). Monitor: Flat panel (24" viewable)
 - 5. Mouse: 2-button with wheel

6. Standard computer keyboard
7. Acceptable Manufacturers
 - a. Avigilon part number VMA-AS3-16P09-NA or approved equal.
8. Provide sufficient storage for 30 days of recorded video retention time using the following assumptions:
 - a. 25% motion
 - b. 15 fps motion record rate
 - c. 1 fps no-motion record rate

2.10 FREE STANDING ENCLOSED EQUIPMENT CABINETS

- A. Provide in accordance with Specification Section 272010 Telecom Distribution System.

2.11 CABINET MOUNTED UPS

- A. The uninterruptible power supply (UPS) shall be Lowell Model UPS9-1500, which shall feature a 4-point rackmount rail kit as well as tower pedestals. The chassis shall measure 17.2" x 19.9" x 3.5" (2U). The UPS shall operate on 120VAC/60Hz current with nominal output of 120V (100/110/115 selectable). Power rating shall be 1500VA (1350W). The UPS shall feature (8) NEMA 5-15R receptacles and 6 ft. cord with 5-15P plug. The UPS shall include a battery that is hot-swappable and has a run time of 8 minutes (half load) or 3 minutes (full load). The unit shall include a CD with ViewPower software. Provide in each CCTV cabinet the number of rack mount UPSs as noted on the drawings. The UPSs' shall have the following operating and rating characteristics:
- B. Specified UPS sizes are based on the product reference standards, specified system design. Provide UPSs, based on the Contractor's final system design, sized at 25% future power output expansion for a backup run time of one half hour at maximum load.

2.12 CABINET MOUNTED POWER DISTRIBUTION/SURGE SUPPRESSION STRIPS

- A. Provide cabinet mounted power distribution strips/surge suppression strips for mounting in the equipment cabinets furnished in accordance with Specification Section 272010 Telecom Distribution System.

2.13 SPECIAL EQUIPMENT

- A. Special hardware, software, tools, test equipment, programming or initialization equipment needed to modify or maintain any part of the CCTV System or its components shall be provided as part of the CCTV System.

2.14 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Any item of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional NVRS System shall be provided in a level of quality consistent with other specified items.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment in strict accordance with the manufacturer's recommendations.
- B. The installation shall comply with the requirements of NEC, OSHA and the rules, regulations and requirements of the FCC.
- C. The installation shall also comply with federal, municipality, and state laws, ordinances, regulations, and codes applicable to the installation.
- D. The Contractor shall ground all NVRS/CCTV equipment installed to the grounding bus bars provided in the CCTV or telecom equipment cabinets.
- E. All wiring at cameras shall be concealed and not exposed. The Contractor shall install wiring through camera mounts and housing or conduit / flexible conduit where required.
- F. Provide labels on installed equipment. Labels shall be permanent, waterproof, and readable from one foot with permanent lettering and shall not be removable by normal cable handling or normal operations.
 - 1. Screws for all junction boxes, pull boxes, and camera mounts and enclosures shall be tamper resistant.

3.2 CONFIGURATION AND PROGRAMMING

- A. Provide all software, software licenses and programming for a complete and fully operational NVRS system, including but not limited to, all system interfaces graphics development, and camera setup.
- B. Identify and request from the Contracting Agency any additional data needed to provide a complete and operational NVRS. Submit request to the Contracting Agency 30 days prior to programming the system. The Contracting Agency shall provide in writing to Contractor 14 days prior to programming any additional details for configuring the system.
- C. Program and configure the system according to the specifications and drawings and any additional Contracting Agency requirements. The parameters to configure include, but are not limited to:
 - 1. Camera Frame Rates
 - 2. Video Resolution

3. Video compression
 4. Image quality / compression ratio
 5. Video Motion Detection
 6. Continuous and Event recording
 7. IP addressing according to the Contracting Agency's IP scheme
 8. Security Management System on archive server and viewing workstations
 9. Camera Field of Views from the camera survey
 10. Security settings such as password protection
 11. Operator and Administrator levels for users
 12. Monitor call-ups, if required
- D. Obtain the necessary ACC Avigilon Video Management System Standard Edition Licenses, and configure the Video Management software on the NVRS Server to record and manage the video and capture License Plates from a single channel.
- E. Program and configure the Client Video Management software on the Monitoring/Control Workstations to enable users to view live and recorded video. Programming shall include, but not be limited to:
1. Setting passwords protection on the client software
 2. Setting access levels such as administrator, operator or viewer.
 3. Monitor modes such as multi-camera display, full screen view or camera sequencing
- F. Create, develop, and install all graphics required to make the system operational.
1. Graphics shall have sufficient level of detail for personnel to operate the system.
 2. Supply hard copy, color examples at least 8½ inches by 11 inches in size, of each type of graphic to be used for the completed NVRS.
 3. Provide examples of the video annotation used for camera identification.
 4. The graphics examples shall be submitted to the Contracting Agency for review and approval at least 30 days prior to the Contractor programming the system.
- G. Include in the Bid all required costs for four hours of software modifications based on additional Contracting Agency input and direction from the Contracting Agency at time of system acceptance.

3.3 SYSTEM OPERATION

- A. The system shall provide continuous recording of video signals from cameras during normal work hours and event recording after hours. Event recording shall be triggered by the use of Video Motion Detection either directly at the camera or programmed into the Video Management System. Coordinate with the Contracting Agency on the exact hours to program into the system for continuous and event recording.
- B. The system shall automatically send notification to YCHC personnel via email upon activation of event recording after hours if so desired.
- C. The system shall use non-proprietary versions of MPEG-4 and M-JPEG video compression standards to allow the system integrate with standard IP-based networking and PC equipment.

3.4 TESTING

A. Preparation

- 1. Prior to Final Acceptance Testing the Contractor shall inspect items of equipment and systems to ensure that:
 - a. Installation is in accordance with manufacturer's instructions and recommendations.
 - b. No defective items have been installed and there are no loose connections.
 - c. System software and firmware are completely installed and fully operational.
- 2. The Contractor is required to provide and submit evidence of their completion of the manufacturer's checklists or test procedures prior to receiving approval to proceed with Cutover for new software installations.
- 3. Cabling is properly labeled, neat, and properly secured.
- 4. Power supplies are correct voltage, phasing, and frequency.
- 5. Grounding and transient protection systems are properly installed.
- 6. System documentation is complete, accurate, and has been properly submitted.

B. Test Plan

- 1. The Contractor shall prepare a Test Plan. The approved Test Plan shall serve as the basis for the detailed test procedures used in the field.
- 2. The Test Plan shall:
 - a. Include an overall testing schedule for tests to be performed.
 - b. Describe the schedule and method by which the Contractor shall perform testing of the system.
 - c. Describe the types of test equipment, software, hardware, and simulators, proposed for each testing phase.
 - d. Define and detail the test methodology for verifying the system requirements, satisfying the performance and availability criteria, and satisfying the Specifications.

3. The Contractor shall update the Test Plan as necessary and obtain the Contracting Agency's written acceptance of the Test Plan prior to beginning any testing.

C. Testing

1. Provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.
2. Written notification of planned testing shall be given to the Contracting Agency at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific Test Plan.
3. Ensure that test procedures confirm each specification statement and manufacturer requirement has been met or exceeded. An actual demonstration of each system function and a simulation of each system failure shall be provided.
4. An acceptance test period of thirty days shall begin at the start of the acceptance test. Any system failure during the acceptance test period will suspend the acceptance test. The thirty-day test period will restart when the required repairs have been made and certified.
5. Perform all tests in the presence of the Contracting Agency. The Contracting Agency reserves the right to accept any portion or activate any phase prior to acceptance of entire system.
6. As part of the field testing, make a DVD recording showing typical day and night views of each camera in the system and deliver the DVD with the report to the Contracting Agency. The DVD shall be recorded using the R/W DVD installed at the site. Submit the original DVD to the Contracting Agency as part of the documentation of the system.
7. The field testing shall as a minimum include:
 - a. Verification that the video and signal or control cabling has been installed, tested, and approved.
 - b. Verification that the NVRS is fully functional.
 - c. Operation of all electrical, mechanical and software controls and verification that the control performs the designed function.
 - d. Verification that all other ancillary and remote video equipment is functioning properly.
 - e. Verification that video equipment with alarm indicators annunciate alarms properly and under the correct conditions.

3.5 FIRESTOPPING

- A. Firestop, per the applicable codes, all fire-rated walls, floors or ceilings penetrated when installing the devices provided under this Specification Section.
- B. Provide fire resistant UL approved firestopping systems to restore fire ratings to all wall, floor or ceiling penetrations. Firestopping systems must be UL classified and meet NEC and MOA.

- C. All firestopping materials shall be installed in accordance with the manufacturer's directions and recommendations.

3.6 DEMONSTRATIONS AND TRAINING

- A. Provide demonstrations and training in accordance with Section 017900 - Demonstrations and Training

END OF SECTION 282310

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SECTION 283100 - ADDRESSABLE FIRE ALARM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification covers the requirements for the materials, installation, programming and configuration of a complete Addressable Fire Alarm System
- B. Furnish labor, equipment and materials to provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein this Section.

1.2 REFERENCES

- A. The equipment and installation shall comply with the current provisions of the following Codes and Standards:
 - 1. National Electric Code, Article 760.
 - 2. National Fire Protection Association Standards:
 - NFPA 72 National Fire Alarm Code
 - NFPA 101 Life Safety Code
 - 3. Local and State Building Codes.
 - 4. Local Authorities Having Jurisdiction.
 - 5. ULC, CSFM, BSA
 - 6. Underwriters Laboratories Inc.
- B. The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:

UL 864/UOJZ, APOU	Control Units for Fire Protective Signaling Systems
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Applications.
UL 217	Smoke Detectors Single Station.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 228	Door Holders for Fire Protective Signaling Systems.
UL 464	Audible Signaling Appliances.
UL 1638	Visual Signaling Appliances.

UL 38	Manually Activated Signaling Boxes.
UL 346	Waterflow Indicators for Fire Protective Signaling Systems.
UL 1971	Standard for Signaling Devices for the Hearing Impaired.
UL 1481	Power Supplies for Fire Protective Signaling Systems.

- C. Americans with Disabilities Act (ADA).
- D. International Standards Organization (ISO).
 - 1. ISO-9000.
 - 2. ISO-9001.

1.3 RELATED SECTIONS

- A. 260000 - Electrical General Requirements
- B. 260519 - Low Voltage Electrical Power Conductors and Cables
- C. 260533 - Raceways and Boxes for Electrical Systems
- D. 272010 - Telecom Distribution System

1.4 SCOPE

- A. Provide in operating condition an electrically operated, electrically supervised digital fire alarm system as described herein. The system shall include, but not be limited to, control unit, power supplies, alarm initiating and notification devices, conduit, conductors, fittings and accessories required to provide a complete operating system. Units shall be located in accordance with plans.

1.5 QUALITY ASSURANCE

- A. Qualifications of Contractor
 - 1. The Contractor shall have successfully installed similar system fire alarm system including; detection, monitoring, controls audible and visual signaling, controls, components wiring and controls under a previous project of comparable size and complexity. The Contracting Agency reserves the right to reject any control components for which evidence of a successful prior installation performed by the Contractor cannot be provided.
 - 2. The Contractor shall have in house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall:
 - a. Perform the detailed engineering design of central and remote control equipment.
 - b. Produce panel and equipment drawings and submittals, and operating manuals.

- c. Coordinate system installation requirements, and final system testing and commissioning in accordance with these specifications.
- 3. The installation of the system shall conform to the State of Alaska regulations.
- 4. The Manufacturer shall be a nationally recognized company specializing in fire alarm systems and shall employ factory trained, NICET certified technicians. The Manufacturer shall maintain a service organization in Alaska and have a minimum of 5 years of experience in the fire alarm industry.
- 5. The installer shall be a company specializing in the installation of fire alarm systems and be factory certified by the Manufacturer for their system. The installer shall have a minimum of 3 years of experience installing fire alarm systems. The installation shall be fully field verified by a factory trained and authorized technician and hold a NICET Level III certification.

1.6 SUBMITTALS

- A. Provide submittals all products in accordance with Section 260000 - Electrical General Requirements and Division 1.
- B. Delete or strike out superfluous information from submittal data, such as model numbers and options for equipment contained on manufacturer's data sheets but not used on this project.
- C. Submit product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- D. Shop Drawings shall include drawings, details and calculations as required per the IFC 907.1.2 Fire Alarm Shop Drawings and the Authority Having Jurisdiction (AHJ).
- E. Submit shop drawings of the system. Shop Drawings shall include the following:
 - 1. Manufacturer's catalog information with complete description of panel mounted and remote equipment.
 - 2. Conduit and device layouts, including location of the Fire Alarm Control Panels (FACPs), devices, circuiting and annunciator(s).
 - 3. One-line risers and point-to-point wiring diagrams prepared specifically for this project.
 - 4. Calculations verifying that SLC and notification appliance circuits voltage drops do not exceed the limits further specified in this Section.
 - 5. Calculations verifying standby battery capacity per NFPA 72, including manufacturer's published current consumption data for all equipment on the System.
 - 6. Construction schedule and phasing/work plan.

7. Scaled plan and elevation drawings for main FACP and main remote annunciator installation.
 8. Layout for the main FACP and remote annunciator detailing the display and controls layout. The detail(s) shall include display, pushbuttons, switch and softkey controls with control labels and designations.
 9. System Sequence of Operation - description and matrix including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
 10. Product certification signed by a certified representative of the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 11. Records of system acceptance and certification – Submit upon completion of system testing certification.
- F. Submit required Shop Drawings and documentation to the Authority Having Jurisdiction and obtain a written statement of Approval of the proposed system.
- G. Operation and Maintenance Manuals: Submit electronic (pdf) files for review for the Operation and Maintenance Manuals (O&M Manuals) in accordance with Section 260000 - Electrical General Requirements and Division 1. Upon final acceptance of the O&M Manuals review; furnish complete hard copy sets and electronic (pdf) files of the final approved O&M Manuals

1.7 WARRANTY AND SERVICE

- A. Warrant all components, parts and assemblies against defects in materials and workmanship for a period of 12 months from date of final completion. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site.
- B. Service availability: The supplier shall have sufficient stock on hand and have a fully equipped service organization capable of guaranteeing response time within 8 hours of service calls, 24 hours a day, 7 days a week to service completed systems.

PART 2 - PRODUCTS

2.1 GENERAL

- A. These specifications are based on equipment from Simplex (4010ES) to set a standard for design and quality. Equipment manufactured by AutoCall, Siemens or Edwards are acceptable alternatives, providing that sufficient documentation is provided to the Contracting Agency that certifies that their equipment meets the requirements of these specifications.
- B. Equipment furnished for this project shall be new and unused. Components and systems shall be designed for uninterrupted duty. Equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be the best suited for the intended use.
- C. Shall be UL Listed under UL 864 for Fire Detection and Control (UOJZ) and Smoke Control Service (UUKL).
- D. Equipment provided shall be of a single manufacturer to insure compatibility between the appliances and the control panel(s), and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.
- E. If any equipment or device connected to the fire alarm system is provided by a different manufacturer, that equipment shall be recognized as compatible by both manufacturers and listed by Underwriters Laboratories or other approved National Recognized Testing Laboratory (NRTL).

2.2 FIRE ALARM CONTROL PANEL

- A. Fire Alarm Control Panel(s) shall be Simplex 4010ES series and shall incorporate all control electronics, relays and necessary modules and components.
- B. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- C. The following FACP features, performance requirements and components shall be provided:
 - 1. Power Limited base panel with cabinet and door, 120 VAC.
 - 2. 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
 - 3. 2000 points of annunciation where one (1) point of annunciation equals:
 - a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
 - b. 1 LED on panel or 1 switch on panel.
 - 4. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.

5. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
 6. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
 7. Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
 - a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.
 - b. Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
 8. Intelligent Remote Battery Charger for charging up to 110Ah batteries.
 9. Power Supplies with three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion.
 - a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.
 - b. Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
 10. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
 11. The FACP shall support up to (5) RS-232-C ports capable of two-way communication and one service port.
 12. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
 13. Programmable DACT for either Common Event Reporting or per Point Reporting.
 14. Fire Panel Internet Interface to provide supplemental notification and remote user access to the FACP using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.
- D. Alphanumeric Display and System Controls: Panel shall include a multi-line QVGA LCD display capable of supporting a minimum of 854 standard ASCII characters to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- E. LCD display on Fire Alarm Control Panel shall be programmed to give English-language description of each device by type, identifying number, and location. Example: "Sprinkler Zone 1 Flow Switch #01 (1983 Boiler Room)." Use actual room numbers, where available.

2.3 REMOTE ANNUNCIATOR PANEL

- A. Remote annunciator panel(s) shall be Simplex 4010ES series.

- B. Provide a remote annunciator as indicated on the drawings. The remote annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys as the FACP.
- C. The remote annunciator shall have an expanded content, multi-line QVGA LCD display capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions.
- D. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message, the current time and date, and the quantity of abnormal status conditions for each event category (i.e., fire alarm, priority 2, supervisory, and trouble)
- E. LCD display on the remote annunciator shall be programmed to give English-language description of each device by type, identifying number, and location. Example: "Sprinkler Zone 1 Flow Switch #01 (1983 Boiler Room)." Use actual room numbers, where available.

2.4 ADDRESSABLE DETECTORS

A. General:

- 1. Each addressable detector shall include a sensor base containing a microprocessor control unit for scanning the sensor, analyzing the sensor output and communicating the sensor status to the FACP and a separate sensor containing the actual sensing instrumentation.
- 2. The sensor connects to the sensor base with a twist-locking plug connection. No special tools shall be required to remove sensor from the base once it has been installed. Removal of the sensor from the base shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
- 3. The control unit shall scan each sensor for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor, but shall indicate a "Wrong Device" trouble condition.
- 4. The sensor's electronics shall be immune from nuisance alarms caused by electromagnetic and radio frequency interference.
- 5. Detectors shall not require resetting or readjustment after actuation to restore normal operation.
- 6. Removal of the sensor head for cleaning shall not require the setting of addresses or remapping of the device.
- 7. Detector assemblies shall be suitable for operation in the following environment:
 - a. Temperature: 32°F to 120°F (0°C to 49°C).
 - b. Humidity: 10-95% RH, non-condensing.

B. Sensor Bases

- 1. Standard Detector Mounting Base:

- a. Bases shall be listed for ceiling or wall mounting.
 - b. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - c. Each sensor base shall include a communication transmitter and receiver having a unique identification and capability for status reporting to the FACP. Device address shall be located in sensor base to eliminate false addressing when replacing sensors.
 - d. Simplex 4098-9792 Standard Sensor Base
2. In-Duct Mounting
- a. Where a smoke detector is required to be directly inserted into a low velocity duct, 4000 ft/min maximum air flow, 3 ft (0.91m) high x 3 ft (0.91m) wide maximum size, provide in-duct mounting base.
 - b. Detector housing shall have visible LED indicator showing power and alarm status.
 - c. In-Duct mounting base shall accept Simplex 4098-9714 Photoelectric Sensor.
 - d. Simplex 4098-9750 In-Duct Mounting or Simplex 4098-9751 In-Duct Mounting with Relay.

C. Sensors:

1. Fixed Temperature/Rate of Rise Heat Detector:
 - a. Fixed temperature/rate of rise heat detectors shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate-of-rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 60 ft (18.3m) spacing on center.
 - b. Simplex 4098-9733 Heat Sensor.
2. Multi-sensor Detector:
 - a. Multi-sensor detectors shall include photoelectric and fixed temperature/rate of rise sensors within the same device. Sensing characteristics shall be the same as described for each standalone sensor detailed above.
 - b. Simplex 4098-9754 Multi-Sensor detector.

D. Duct Smoke Detector Housing:

1. Provide smoke detector duct housing assemblies to accept a standard, relay or isolator detector mounting base and sensor. The housing shall protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
2. Provide remote status/alarm LEDs and Remote Test Stations as shown on the plans or as required by the AHJ.
3. Detector housing shall be listed for operation between 300 and 4,000 FPM (2 and 20.3 m/sec) air velocity.
4. Simplex 4098-9755 or 4098-9756 Duct Sensor Housing with

5. Simplex 2098-9808 or 2098-9806 Remote Status/Alarm and Test Station

2.5 ADDRESSABLE CONTROL MODULES

A. General:

1. Modules shall be capable of monitoring or controlling one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
2. Addressable Modules shall be capable of mounting in a standard North American single gang box. Modules include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
3. Modules shall have a diagnostic LED visible on the finished cover plate. The LED shall flash to confirm communication.
4. Modules shall be suitable for operation in the following environment:
 - a. Temperature: 32°F to 120°F (0°C to 49°C).
 - b. Humidity: 0-93% RH, non-condensing.

B. Provide module styles and quantities as necessary to meet the design requirements:

1. Individual Addressable Modules (IAM):
 - a. Simplex 4090 Series
2. Zone Adaptor Modules (ZAM)
 - a. Simplex 4190 Series
 - b. Simplex 2190 Series

2.6 ADDRESSABLE MANUAL FIRE ALARM STATION

- A. The manual fire alarm station shall have a diagnostic LED visible from the front of the station without removing the cover. The led shall flash to indicate communication and go solid to indicate that the station has been activated.
- B. Manual fire alarm stations shall be suitable for operation in the following environment:
 1. Temperature: 32°F to 120°F (0°C to 49°C).
 2. Humidity: 0-93% RH, non-condensing.
- C. Provide Manual Fire Alarm Station styles and quantities as necessary to meet the design requirements:

1. Simplex 4099 Series addressable stations.

2.7 ADDRESSABLE NOTIFICATION APPLIANCES

A. General:

1. Addressable Notification Appliances shall include the following:
 - a. Shall operate on compatible signaling line circuits (SLC).
 - b. Shall be supervised over a single set pair or wires - unshielded twisted pair (UTP) having a minimum of 3 twists per foot.
 - c. Shall be permitted to be "T" tapped with Class B (Style 4) addressable NACs.
 - d. Shall each operate as a completely independent device and shall be able to operate individually, be grouped into zones or operational groups by central programming at the main fire alarm control unit.
 - e. Shall be permitted to be tested for audible and visible operation on an individual basis at the device or from the main fire alarm control unit.
 - f. Shall include an on-board module to perform appliance diagnostics that assist with installation and test operations.
 - g. Shall include a visible LED on each appliance to provide verification of communications and shall flash with the appliances address setting using a magnetic test tool.
 - h. Shall include electrical test point access without removing the device cover.
 - i. The front cover of the appliance shall be removable without causing a trouble indication on the fire alarm control unit while the appliance is connected to an active circuit.
 - j. Shall be available in both wall mount and ceiling mount configuration.
 - k. Shall be available in white housings and mount in standard electrical boxes.
 - l. Mounting accessories and wire guard as required for the installation
2. Strobe appliances or combination appliances with strobes shall be capable of providing the "Equivalent Facilitation" which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed.
3. Strobe appliances under this section are xenon strobe flash tube and associated lens/reflector system unless otherwise noted

B. Strobes - V/O (Visible Only) :

1. Addressable strobe shall be listed to UL 1971. The V/O device shall consist of a xenon flash tube and associated lens/reflector system, cover and mounting plate.
2. The appliance shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.

3. The appliance shall provide the following selectable flash intensities: 15cd, 30cd, 75cd, 110cd, 135cd and 185cd. The Candela levels shall be settable from the fire alarm control unit or by using a hardware selector on the appliance.

C. Horns – A/O (Audible Only) :

1. Addressable horn shall be listed to UL 464. Horn shall support Temporal Code 3, March Time (20, 60, or 120 BPM), Continuous, and Temporal Code 4 coding patterns.
2. Horn appliances shall have a High/Low Setting, programmable by channel from the addressable controller or by appliance from the host FACP.
3. The horn shall have a minimum sound pressure level of 83 or 89 dBA for steady) or of 79 or 85 dBA for coded operation.
4. The horn device shall consist of three pieces; appliance, cover and mounting plate.
5. The appliance shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings.

D. Horn/Strobes- A/V (Audible/Visible) :

1. Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464.
2. The appliance shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.
3. The appliance shall provide the following selectable flash intensities: 15cd, 75cd, 110cd, 135cd and 185cd. The Candela levels shall be settable from the fire alarm control unit or using a hardware selector on the appliance.
4. The Horn shall support Temporal Code 3, March Time (20, 60, or 120 BPM), Continuous, and Temporal Code 4 coding patterns. The horn shall have a minimum sound pressure level of 83 or 89 dBA for steady or 79 or 85 dBA for coded operation.
5. The appliance shall be capable of two-wire synchronization with one of the following options:
 - a. Synchronized Strobe with Horn on steady.
 - b. Synchronized Strobe with Temporal Code Pattern on Horn.
 - c. Synchronized Strobe with March Time cadence on Horn.
 - d. Synchronized Strobe firing to NAC sync signal with Horn silenced.

2.8 SPRINKLER BELL

- A. Provide electrically operated, 10 inch diameter, red color alarm gong with “Call Fire Dept.” sign. Refer to drawings for locations. Coordinate exact mounting height and location with the Architect. EST 439D-10AW on weatherproof back box.

2.9 ANCILLARY DEVICES

A. Multi Voltage Control Relays:

1. Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be SPDT or DPDT and rated for 10 amperes at 115 Vac. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac, or 230 Vac. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.
2. Simplex 2088 series relays

2.10 ELECTROMAGNETIC DOOR HOLDERS

A. Provide electromagnetic door holders with the following features.

1. Flush mounted wall units or floor units as required by door and application.
2. Silent operation.
3. Minimum 20 lbf (89 N) holding force.
4. Finish shall be aluminum/chrome.
5. Simplex DH Series RSG Electromagnetic Door Holders

2.11 CONDUCTORS

- A. In general, conductors shall be of the sizes and types recommended by the system manufacturer.
- B. Voltage drop on Notification Appliance Circuits shall not exceed 10% at the most distant device on each circuit.

2.12 SPARE CAPACITY

- A. Signaling Line Circuits (SLC) and Initiating Device Circuits (IDC) shall be sized to provide 20% spare capacity to allow future addition of devices.
- B. Notification Appliance Circuits (NACs) shall be sized to provide 20% spare capacity to allow future addition of devices.
- C. NACs shall be limited to maximum 3 ohms loop resistance.
- D. SLCs and IDCs shall be limited to half of manufacturer's recommended maximum capacitance and shall not exceed manufacturer's maximum resistance to the furthest point on the cable.
- E. Signaling Line Circuits and Initiating Circuits shall be limited to 2/3 of the maximum number of devices permitted by the manufacturer per circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The entire system shall be installed in a workmanlike manner in accordance with approved manufacturer's manuals and wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the NEC, approved by local authorities having jurisdiction for the purpose.
- B. Penetration of floor slabs and fire walls shall be fire stopped in accordance with Section 260000 - Electrical General Requirements and with local fire codes.
- C. All wiring shall be in metal raceways shared by no other system. Raceways shall be installed in accordance with Section 260533 – Raceway and Boxes for Electrical Systems.
- D. Field devices shall be installed in accordance with Section 260533 – Raceway and Boxes for Electrical Systems. Paint boxes and covers red.
- E. Install Conductors in accordance with Section 260519 – Low Voltage Electrical Power Conductors and Cables. All wires shall be landed on device terminals, or terminal strips or blocks, and shall be labeled and numbered at their terminations. All wiring shall be installed in a neat and workmanlike manner. Bundles of wiring shall be secured with self-locking nylon cable ties, not tape
- F. Coordinate exact mounting locations with the reflected ceiling plans. Coordinate exact mounting heights with architectural elevations.
 - 1. Where field conditions (such as conflicts with other features, obstructions that violate the placement rules of the applicable Fire Code, and the like) make it necessary to relocate detectors from the positions shown on the plans, such relocations shall be made in strict accordance with the applicable Fire Code, and shall be made at no additional cost to the Owner.
 - 2. As far as possible within the rules of the applicable Fire Code, the final placement of exposed detectors shall present a uniform appearance.
- G. Adjust each detector in accordance with manufacturer's recommendations for the specific location and circumstance.
- H. Coordinate installation of duct-mounted detectors with Divisions 23 and 25. Duct detectors shall be installed in accordance with NFPA 72 and manufacturer's recommendation to the greatest extent practical. Proposed duct detector locations shall be submitted for approval prior to installation of any equipment. Submit duct detector differential pressure measurements to verify proper operation of duct detectors.
- I. Control relays shall be located within 3 feet of the device or circuit controlled in accordance with NFPA 72.

- J. System installation and operations shall be verified by the manufacturer's representative and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the operation of the system and initial staff training as required by the Contracting Agency.
- K. Fire/Smoke Dampers: Coordinate connections to fire/smoke dampers with Division 23.

3.2 FIRE ALARM SYSTEM SEQUENCE OF OPERATION

- A. The system shall identify any off normal condition and log each condition into the system database as an event.
 - 1. The system shall automatically display on the control panel Liquid Crystal Display the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.
 - 2. The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event; alarm - red, supervisory - yellow, trouble - yellow, monitor - green. When an unseen event exists for a given type, the indicator shall flash. When all events of a given type have been displayed, the indicator shall change from flashing to steady.
 - 3. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred.
 - 4. The user shall be able to review each event by simply selecting scrolling keys (up-down) for each event type.
 - 5. New alarm, supervisory, or trouble events shall sound an silenceable audible signal at the control panel.
- B. Operation of any alarm initiating device shall automatically:
 - 1. Update the control/display as described above.
 - 2. Sound all alarm signals throughout the building at the evacuation rate.
 - 3. Turn on all strobe lights throughout the building.
 - 4. Operate the alarm relay contacts to initiate the transmission of an alarm to a central station agency via leased telephone lines.
 - 5. Operate control relay contacts to shut down air supply fans. Shutdowns shall be hardwired from the Fire Alarm System (i.e., not implemented via building automation controls) and immediate acting, and shall not be overridden by Hand-Off-Auto switches or other controls.
 - 6. Operate control relay contacts to release all magnetically held smoke doors throughout the building. Provide separate circuit(s) as necessary for operation of all door holders. If door holders are 120VAC, circuits shall be from the same panelboard used to supply the fire alarm control panel. If door holders are 24V, circuits shall be from the fire alarm control

panel using 120VAC to 24VAC transformers. Door holder circuits shall be fused as necessary to prevent damage to the Fire Alarm System. Submit for approval all proposed power sources prior to installation or connection of equipment.

7. Operate control relay contacts to de-energize smoke/fire dampers to close dampers. Dampers shall typically be interlocked with their associated air handler unit so the dampers close whenever the air handler is de-energized.
 8. Separate Alarm and trouble conditions shall be transmitted to the Building Control System (BCS) and Building Security System. Common alarm, common trouble and common sprinkler alarm conditions shall be monitored by the BCS and Security Systems. Provide separate sets of outputs for the BCS and Security Panels.
 9. Visually annunciate the zone of alarm on the remote annunciator panel. The visual indication shall remain on until the alarm condition is reset to normal.
- C. Activation of a sprinkler supervisory initiating device shall:
1. Update the control/display as described above.
 2. Visually annunciate the zone of alarm on the remote annunciator panel. The visual indication shall remain on until the alarm condition is reset to normal.
- D. Fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or disarrangement of system wiring and shorts across alarm bell/strobe wiring shall automatically:
1. Update the control/display as described above.
 2. Operate the trouble relay contacts to initiate the transmission of a trouble alarm to a central station agency via telephone lines.
 3. Visually and audibly annunciate a general trouble condition, on the remote annunciator panel. The visual indication shall remain on until the trouble condition is repaired.

3.3 ELEVATOR RECALL

- A. The activation of a smoke sensor or detector in any elevator machine room or associated lobby (other than on the Designated Level) shall cause the car(s) that serve that lobby to return nonstop to the Designated Level. If the smoke sensor or detector at the Designated Level is activated the car(s) shall return to an Alternate Level approved by the enforcing authority. (ANSI/ASME A17.1 RULE 211.3b.). Unless otherwise required by the Authority Having Jurisdiction, only the elevator lobby, elevator hoistway (if provided), and the elevator machine room smoke detectors shall initiate elevator recall for fire fighter's service.
- B. The activation of elevator hoistway (if provided) or elevator machine room smoke detectors shall cause separate and distinct visible annunciation at the control unit and required annunciators to alert fire fighters and other emergency personnel that the elevators are no longer safe to use.

C. Elevator Control Circuits:

1. Provide four separate elevator control circuits for each elevator(s). The elevator control circuits shall be terminated at their respective elevator controller in the elevator machine room(s). Operation of the elevators shall be in accordance with ANSI/ASME A17.1, Safety Code for Elevators and Escalators, Rules 211.3 through 211.8. Smoke detectors shall activate the four elevator control circuits as follows:
 - a. Control Circuit #1: Activation of the smoke detector at the Designated Level (designated elevator recall lobby) shall actuate the first elevator control circuit. If the elevator is equipped with front and rear doors, the smoke detectors in both lobbies at the designated level shall actuate Control Circuit #1.
 - b. Control Circuit #2: Activation of the smoke detectors in the remaining elevator lobbies shall actuate the second elevator control circuit.
 - c. Control Circuit #3: Activation of smoke detectors in elevator hoistways and elevator machine room(s) shall actuate the third elevator control circuit. Where the elevator machine room is located at the Designated Level, the elevator machine room smoke detector shall also actuate Control Circuit #1.
 - d. Control Circuit #4: Activate red hat button in elevator(s).

3.4 ELEVATOR SHUTDOWN:

2. A fixed temperature heat detector shall be located adjacent to each sprinkler head (within 12 inches) in the elevator shafts and machine room(s). Detector sensitivity shall be selected to ensure the detector will activate prior to activation of sprinklers (the detector shall have a lower temperature rating and a higher sensitivity, i.e., lower response time index, RTI, compared to the sprinkler head).
3. Activation of the heat detector shall cause the car(s) to return nonstop to the Designated Level. If the smoke detector at the Designated Level is activated the car(s) shall return to an Alternate Level approved by the enforcing authority. Shut-off of electrical power may be delayed to allow elevator capture provided that power is disconnected prior to the application of water in accordance with ASME A17.1 Section 2.8.
4. After activation of a heat detector and prior to the application of water from the sprinkler system, the elevator machine breaker(s) shall be shunt-tripped per ASME A17.1 Section 2.8, and as approved by the local authority having jurisdiction. Elevator car lighting shall not be disconnected .

3.5 FIRE PUMP MONITORING

- A. The fire pump shall be monitored off-site at a constantly attended location in accordance with NFPA 20 requirements for the following conditions:
 1. Fire pump has operated into a pump running condition.
 2. Loss of line power on the line side of the fire pump motor starter.
 3. Phase reversal on the line side of the fire pump motor starter.

4. Where two sources of power are supplied to the fire pump to meet requirements of NFPA 6-2.3, this alarm circuit shall indicate whenever the alternate source is the source supplying power to the controller. This alarm circuit shall be energized by a separate reliable, supervised power source, reduced to not more than 125V.
- B. Monitoring shall be provided by the building Fire Alarm System. Connect to relay contacts at Fire Pump Controller. Coordinate all monitoring and connection requirements with Division 21.

3.6 DETECTORS FOR DOOR RELEASE SERVICE

- A. Ceiling-mounted detectors for door release service shall be centered on the opening, at a maximum distance of 5'-0" from opening. Minimum distance from opening shall be as noted in NFPA 72.

3.7 MAGNETIC DOOR HOLDERS

- A. Unless otherwise noted or specified or dictated by the specified holder design, magnetic door holders shall be mounted near the top of the doors they serve, and within 6" of the latch-side edge of each door served.
- B. Door holders shall produce no objectionable hum. Repair, replace, or relocate all holders that produce audible hum.

3.8 DOOR UNLOCKING DEVICES

- A. Any device or system intended to effect the locking/unlocking of emergency exits shall be connected to the building fire alarm system. These exits shall unlock upon receipt of any fire alarm signal.
- B. All emergency exits connected in accordance with (A.) above, shall unlock upon loss of the primary power to the fire alarm system. The secondary power supply shall not be utilized to maintain these doors in locked condition.

3.9 PROTECTION OF FIRE ALARM CONTROL UNITS

- A. Provide automatic smoke detection at the location of each fire alarm control unit(s) including fire alarm control panels, remote power supplies and remote battery supplies.

3.10 INTERCONNECTIONS TO OTHER SYSTEMS

- A. Provide input modules for monitoring of sprinkler flow, tamper, and low air pressure switches. Provide sufficient modules to give each switch an individual address. Connect supervised circuits from modules to switches and program system to provide specified functions for each switch.

3.11 REMOTE DETECTOR INDICATORS

- A. Provide remote LED indicators for all duct mounted smoke detectors where the detector is mounted where the LED alarm indicator is not easily visible. Provide a descriptive label in accordance with Section 260000 - Electrical General Requirements - IDENTIFICATION.

3.12 EXAMINATION AND DEMONSTRATION

- A. Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm / Life Safety System and all associated components are to be installed shall be made.
- B. Each of the intended operations of the installed Fire Alarm System shall be demonstrated to the Contracting Agency and the Local Authority Having Jurisdiction by the Installing Engineered System Distributor.

3.13 TESTING AND REPORTS

- A. Upon completion of the system installation, an Approved representative of the system manufacturer shall conduct a thorough test of the system and all related devices and components of the system, and submit a written report of the findings to the Contracting Agency at least 72 hours prior to the substantial completion site observation. The testing shall include, at the least, verification of the following:
 - 1. The functional operation of each resettable initiating device (manual fire alarm boxes, detectors, etc.) and circuit.
 - 2. The functional operation of each and every alarm device and circuit.
 - 3. The functional operation of each monitored device circuit.
 - 4. The functional operation of each control and output circuit.
 - 5. The supervision function of each Initiating, Indicating, Monitoring, Control and Supply Circuit.
 - 6. Central Station automatic signaling.
 - 7. Proper initiation and execution of mechanical systems control sequences.
 - 8. Verify that wire size, power supply, number of devices on a circuit, etc. are suitable to support 100% of devices being in alarm or operated simultaneously. Test shall include the following as a minimum:
 - a. Place all detectors and monitor modules in alarm. Each shall display its address and alarm condition. At least the first ten devices on each circuit shall also have their alarm LEDs lighted, where applicable.
 - b. Operate all control modules for the alarm or operated condition. Each module shall display its address and condition.

- c. Reset all alarmed and operated devices. The panel shall display the address of any off-normal devices.
- 9. Test a representative number of detectors for alarm verification by momentarily testing for alarm. The detectors shall not initiate an alarm. Then test by placing the detectors in alarm such that it remains in alarm for the selected verification time. The detector shall initiate an alarm.
- 10. Test a representative number of detector for trouble by removing the detector from its base. The address and trouble condition for each shall be displayed. Insert a different type of detector into the base. The address and trouble condition shall be displayed. The detector shall return to normal only when the proper detector type is reinserted into the base.
- 11. Print out the English-language descriptor, currently sensed value, prealarm threshold value, alarm threshold value and status of each sensor in the system. Also print out the English-language descriptor and status of each module in the system. The printout shall also include the date and time.

3.14 TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- B. After the system provided in this Section is completely installed and operational, and at a time chosen by the Owner, provide the Owner's system operators and maintenance personnel and representatives of the local Fire Department with a total of eight (8) hours of instruction on the operation, maintenance, and troubleshooting of all equipment provided under this Section.
- C. Training sessions shall be presented by a fully qualified, trained representative of the equipment manufacturer, who is thoroughly knowledgeable on the specific installation. Separate sessions shall be given for operation personnel (i.e.: facility staff and Fire Department) and maintenance personnel, with the length and content of the sessions tailored to the respective groups.
- D. Provide an additional two (2) hours of follow-up instruction for review and clarification at a later time mutually agreed on with the Owner, if the Owner deems it necessary.
- E. Training sessions shall be recorded (video and audio) in digital format. Two (2) copies of the recorded sessions shall be provided on a portable USB thumb drive to the Owner.

END OF SECTION 283100

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