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 it's 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 it's 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/otpca/nrtl/

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 MULTIWIRE 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 condulet) 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 contaminates.

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, Liquatite “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 ¾ 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 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 ¾ 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 THROUGHS

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:

	Size of Box			
Maximum Trade Size Conduit	Width (inches)	Length (inches)	Depth (inches)	For Each Additional Conduit Increase Width
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:				
	Phase A	Phase B	Phase C	Neutral
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 Section260519 – 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:

MLO Mode		State of load after each pushbutton press			
		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

1. Device color for wall mounted devices shall match device color for wiring devices. Refer to Section 262726 - Wiring Devices.

2. Device color for ceiling mounted devices shall be white.

3. 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)

1. 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 sounds 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 for100 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 Ip & 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 drwings.
   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 (In), 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 lr, 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 Ir.
   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 ln
      600A, from 1.5 to 11 times ln
      400A from 1.5 to 12 times ln
      250A and below, from 1.5 to 15 times ln

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 +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 +/- 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 it's 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 Requirments __ 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 date and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control though 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 (VL_{AVE})
   - 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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