

PART 1 - GENERAL

1.01 CONTRACT DOCUMENTS

- A. Unless otherwise modified, provisions of General Conditions, Supplementary Conditions and Division-01 govern work under the Electrical Divisions.
- B. The drawings and specifications shall be followed in layout of work.
- C. For the new generator building, the Architectural drawings shall be used for all dimensional information. Do not scale from the Electrical drawings.
- D. Contract Document Interpretation/Discrepancies:
 - 1. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the Architect/Engineer (A/E) of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the A/E.
 - 2. In addition, should any contradiction, ambiguity, inconsistency, discrepancy or conflict appear in or between any of the Contract Documents, the Contractor, shall, before proceeding with the work in question, notify the A/E and request an interpretation. In no case shall he proceed with the affected work until advised by the A/E.
 - 3. If the Contractor fails to make a request for interpretation of discrepancies or conflicts in the drawings or specifications, no excuse will be accepted for failure to carry out the work in a satisfactory manner, as interpreted by the A/E. In all cases, the Contractor will be deemed to have estimated the most stringent materials and methods (i.e. the highest quality materials and most expensive manner of completing the work) unless he has requested and obtained written authorization as to which methods or materials will be required.
 - 4. Each and every trade or subcontractor will be deemed to have familiarized himself with all drawings of this project, including Site/Civil, Architectural, Structural, Mechanical, Electrical, etc. so as to avoid coordination errors, omissions, and misinterpretations. No additional compensation will be authorized for alleged errors, omissions, and misinterpretation, whether they are a result of failure to observe these requirements or not.
- E. The complete set of Architectural, Structural, Civil, Mechanical, and Electrical drawings and specifications apply to this work.

1.02 DESCRIPTION

- A. Unless otherwise modified in other Sections, or on the contract drawings, which define the scope and arrangement of the electrical work to be provided, the applicable provisions of these General Requirements shall govern the furnishing of all supervision, labor, equipment, tools, services, and materials necessary to

install a complete electrical system ready for continuous and successful operation. The work shall include, but not be limited to, the furnishing and installation of the following items, as applicable:

1. Electrical services meeting the requirements of and in coordination with the local electric power company. Refer to the latest edition of the local power company manuals for service details.
2. Power panelboards, and all required overcurrent devices.
3. Power feeders, branch circuit wiring, and disconnect switches for mechanical equipment.
4. Lighting and receptacle feeders and branch circuit wiring.
5. Lighting fixtures.
6. Exit and emergency lighting.
7. Generator and Load Bank.
8. Fire alarm system.

1.03 PERMITS, INSPECTION AND CERTIFICATION

- A. Permits: Refer to the General Conditions of the Contract.
- B. Inspections: Refer to the latest edition of the local power company manuals for service inspection requirements.
- C. Certifications:
 1. Certificates of final inspection and approval required by agencies or authorities having jurisdiction shall cover all electrical work.
 2. All certificates of final inspection and approval shall be delivered to the Engineer prior to final acceptance of the electrical work.

1.04 CODES, STANDARDS AND REFERENCES

- A. The electrical work covered under the specifications and drawings shall be performed in strict accordance with the latest adopted edition of the following codes and standards:
 1. National Electrical Code (NEC), NFPA 70
 2. Applicable codes and standards of the National Fire Protection Association (NFPA)
 3. National Electrical Safety Code, ANSI C2
 4. International Building Code (IBC)
 5. All authorities having jurisdiction
- B. The work covered under the specifications and drawings shall be performed using the following references as minimum standards for construction and testing:
 1. American National Standard Institute (ANSI)
 2. National Electrical Manufacturers' Association (NEMA)
 3. Underwriter's Laboratories (UL)
 4. The Occupational Safety and Health Act (OSHA)

5. InterNational Electrical Testing Association (NETA)
 6. Applicable standards of the utility company and the telephone company
 7. American Society of Testing Materials (ASTM)
 8. Institute of Electrical and Electronic Engineers (IEEE)
 9. Illuminating Engineering Society (IES)
 10. Insulated Cable Engineers Association (ICEA)
- C. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in "Electrical Construction Material List" of the Underwriter's Laboratories, Inc. (UL) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the "Electrical Appliance and Utilization Equipment List" of the Underwriter's Laboratories, Inc. (UL) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by a Nationally Recognized Testing Laboratory (NRTL), inspection agency or approved organization shall be acceptable.

1.05 CLARIFICATION OF DRAWINGS

- A. Should a bidder find discrepancies in or omissions from the drawings or specifications, or should he be in doubt in regard to their intent, the Contractor shall notify the Engineer before submitting bid proposal. The Engineer shall then send written instructions to all bidders.

1.06 SUBMITTALS, REVIEW AND ACCEPTANCE

- A. Complete shop drawings and material lists shall be submitted by the Contractor for review by the Engineer in accordance with the requirements of the GENERAL PROVISIONS. Equipment and materials for which shop drawings are not submitted shall be provided as specified, and other manufacturers and products will not be allowed. No work shall be fabricated or ordered by the Contractor until approval has been given by the Engineer.
- B. Complete shop drawings showing dimensions, materials, arrangements, and other pertinent data shall be submitted.
- C. Complete lists of materials and equipment shall be submitted. Full description catalog or other data shall be submitted.
- D. Shop drawings and material lists shall be submitted for, but not limited to the following:
1. Conduit
 2. Wire
 3. Boxes, Fittings, and Wire Troughs
 4. Cabinets
 5. Wiring Devices
 6. Panelboards
 7. Safety Switches
 8. Low Voltage Fuses

9. Enclosed Circuit Breakers
 10. Lighting Fixtures and Components
 11. Motor Starters
 12. Automatic Transfer Switches
 13. Emergency Generator
 14. Emergency Lighting Equipment
 15. As elsewhere indicated on the drawings or in the specifications.
- E. Submittals shall include but not be limited to the following information: Size, type, functional characteristics, compliance with standards, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Document requirements.
- F. Shop drawings shall include plans, elevations, sections, mounting details of component parts, point to point interconnection diagrams, elementary diagrams, single line diagrams, and any other drawings necessary to show the fabrication and connection of the complete item or system.
- G. Submit shop drawings and/or diagrams for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings or where the proposed installation differs from that shown on the contract drawings.
- H. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:
1. Grounding Systems
 2. Fire Alarm Systems
 3. As indicated elsewhere on the drawings or specifications.
- I. Submit 1/4" (6 mm) or 1/2" (13 mm) scale plans showing layout of equipment in electrical equipment rooms and closets, etc., indicating sizes of equipment, dimensions, clearances, etc. based on equipment being installed.
- J. Prepare and stamp each submittal in a form indicating that the documents have been contractor reviewed, are complete and are in compliance with the requirements of these contract drawings and specifications.
- K. In general, catalog cuts, specification sheets, descriptive data, etc., shall be acceptable for submittal of all equipment specified by standard catalog numbers, unless otherwise noted in the construction documents.
- L. Shop drawings shall be clearly legible; poor reproductions or reduced photographic copies that are not legible shall be rejected.
- M. Before submission of shop drawings the Contractor shall carefully check same for proper capacity, operating characteristics, physical arrangement accessories, etc., as specified or noted on drawings. If shop drawings are submitted and indicate little or no prior checking by the Contractor, they shall be rejected.

N. Submittal Identifications:

1. Place a permanent label or title block on each submittal for identification.
2. Indicate name of firm or entity that prepared each submittal on label or title block.
3. Provide a space approximately 4 by 5 inches on label or beside title block to record contractor's review and approval markings and action taken by A/E.
4. Include the following information on label for processing and recording action taken:
 - a. Project name
 - b. Date
 - c. Name and address of A/E
 - d. Name and address of contractor
 - e. Name and address of subcontractor
 - f. Name and address of supplier
 - g. Name of manufacturer
 - h. Unique identifier, including revision number
 - i. Number and title of appropriate specification section
 - j. Drawing number and detail references, as appropriate
 - k. Other necessary identification
 - l. Example: 16120-01-0
 - 16120 references the spec section
 - 01 indicates this is the first submittal from this spec section
 - 0 indicates this is the original submittal (where 1 would indicate this is the first re-submittal)

O. Submittals not in compliance with the requirements of this section will be returned without review.

P. The review of shop drawings will be general and shall not relieve the Contractor from sole responsibility for errors or omissions of any sort, nor for proper fitting and construction on work or the furnishing of materials or work required by the Contract Documents but not shown or indicated on the shop drawings. Approval shall not imply verification of required quantity of material, nor correctness of dimensions. Requests by the Owner's Representative for changes and corrections on shop drawings shall not be construed as an order for extra work under the contract.

Q. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish the named item, or equivalent, subject to acceptance. Suitability of only the named item has been verified. Where more than one item is named, only the first named item has been verified as suitable.

R. Substituted items or items other than first named shall be equal or better in quality and performance and must be suitable for the available space, required arrangement, application, and clearances. Submit any and all data necessary to

determine the suitability of substituted items. Substitutions must be submitted for consideration seven (7) days prior to the original bid date. Consideration of substitutions shall be at the sole discretion of the Engineer. Substitution submittals shall include all information required in the "Submittals" sub-section of this specification section, as well as all other requirements indicated throughout the Division-16 specifications. All changes incurred as a result of a substitution shall be provided at no additional cost to the Owner.

- S. Substitutions will not be permitted for specific items of material or equipment where specifically noted.
- T. Compliance Review Form: Each equipment submittal must include a Compliance Review Form formatted as follows:
 - 1. Section 1: Certify that the submittal is in complete compliance with the plans and specifications, except for the numbered and footnoted deviations and exceptions as defined herein. Deviations or exceptions taken in a cover letter or by contradiction or omission shall not constitute a release from the requirement that the equipment be in complete compliance with the plans and specifications.
 - 2. Section 2: Provide a detailed paragraph by paragraph annotation of the specification with an individual "C", "D", or "E" noted in the margin, as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.
- U. Electronic Submittals: Should the contractor elect to submit electronic shop drawings/submittals, the procedure shall be as follows:
 - 1. Provide a transmittal with the electronic shop drawing/submittal indicating that the document was transmitted electronically. Transmittal shall also include verification of the contractor's review indicating compliance with the contract documents.
 - 2. Sequentially number all pages on the electronic shop drawing/submittal. The total number of pages shall be reflected in the transmittal.
 - 3. Submittal review comments shall be transmitted electronically. Large documents will be scanned with comments as necessary and returned electronically.

4. All shop drawings such as, but not limited to: coordination drawings, ductwork shop drawings, fire alarm drawings, ductbank layouts, etc. shall be submitted in hard copy, full size format.
 5. Provide hard copy of the shop drawing/submittal for each of the Operations and Maintenance Manuals.
 6. Failure to comply with the above will result in the submittal being returned and marked "Not Reviewed".
- V. The engineer will provide a maximum of two (2) submittal reviews per equipment submittal; the initial review plus one (1) re-submittal. Should the re-submittal be returned "Not Acceptable" or "Revise and Resubmit", the contractor shall choose one of the following courses of action:
1. Provide the exact manufacturer and model indicated in the contract documents as the basis of design, or
 2. Reimburse the engineer for all additional review time required to achieve a submittal review from the engineer of "No Exceptions Taken."

Should the contractor choose option 2 above, the engineer shall be reimbursed at an hourly rate of \$175 per hour with payment due prior to the return of the final submittal. In addition, the contractor shall accept complete responsibility for all delays resulting from the submittal review process extending beyond two (2) reviews per equipment submittal.

- W. Resubmittals: Resubmittals shall comply with paragraph 1.06 of this section and the following additional requirements.
1. Resubmittals shall include a written response to each submittal comment. Provide a detailed comment by comment annotation of the submittal review comments with an individual "C", "D", or "E" as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

1.07 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of electrical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible electrical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the owner upon completion. If requested, the electronic CADD documents shall be up-loaded to the owner's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the owner's preferred version of AutoCad. Coordinate with the owner before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.
- D. Computer (CADD) files of electrical drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

1.08 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Upon completion of all work, the Contractor shall thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance. Instructions shall be given only by experts in the equipment or systems and shall include descriptions and demonstrations for procedures of operation, data record keeping, etc.

- B. The Contractor shall demonstrate, by actual usage, the proper operation of each and all portions of the various systems to the Owner or his appointed representative. Additional instructional periods shall be provided as required elsewhere in these specifications.
- C. Following completion of the Electrical Contract and prior to the instructional period and final acceptance of the contract, the Contractor shall prepare three (3) Operating and Maintenance Manuals describing the electrical systems and equipment. Data in the manuals shall include, but not be limited to, the following:
 - 1. Test results for all testing conducted in accordance with Division-16 Section, "Inspections, Testing and Start-up".
 - 2. List of materials and equipment with name and address of vendor.
 - 3. List of lamps, fuses (style and ampere rating), overload heaters, and other expendable equipment and devices with type, size or ordering description with name and address of vendor.
 - 4. Operating, maintenance, and installation instructions for all systems and components with name and address of vendor and servicing supplier.
 - 5. A certificate of approval from the Electrical Inspector.
 - 6. A final copy of the approved coordination, short circuit and arc flash study.
 - 7. Final copies of shop drawings and submittals.
 - 8. Manufacturer's guarantees and warranties.
- D. Manuals shall be of the loose leaf type, in heavy duty binders, with a master index and dividers with plastic tabs indicating system and equipment described.
- E. Contractor shall training and (2) video of training.

1.09 RISER PLAQUE

- A. Provide a computer generated riser diagram, 24" x 36" (600 mm x 900 mm) (nominal), of the completed distribution system showing incoming services, distribution boards, feeders, transformers, panelboards, and related equipment. All feeders and circuits shall be sized and all equipment identified. Drawing shall be framed with plexiglass overlay.

1.10 GUARANTEE

- A. Guarantee obligations shall be as hereinbefore specified in the GENERAL PROVISIONS of these specifications, except as follows:
 - 1. Guarantee the complete electrical system free from all mechanical and electrical defects for a period of two (2) years beginning from the day of final acceptance of the work or beneficial occupancy by the Owner, whichever occurs first.
 - 2. During the guarantee period, the Contractor shall be responsible for the proper adjustments of all systems, equipment and apparatus installed by

him and do work necessary to insure efficient and proper functioning of the systems and equipment.

3. Upon receipt of notice from the Owner of failure of any part of the electrical installation during the guarantee period, new replacement parts shall be furnished and installed promptly at no cost.
4. Within the two (2) year warranty/guarantee period, manufacturer's recommended maintenance shall be provided by the Contractor.

1.11 DEFINITIONS

A. The following definitions apply to firestopping:

1. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
2. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
3. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases and smoke.
4. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
5. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
6. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
7. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

- A. All materials and equipment shall be new, the best of their respective kinds and suitable for the conditions and duties imposed on them. Replacement parts shall be available. A permanent service organization maintained or trained by the manufacturer shall be available for service.
- B. The Contractor shall set-in place and connect all electrical equipment furnished under Division-16 and all other Divisions of the Contract.
- C. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.
- D. Include any and all items required by the National Electrical Code and field conditions for the proper connection and installation of each piece of equipment.

- E. Products of one manufacturer shall be used where two or more items of the same kind are required.

2.02 EQUIPMENT DEVIATIONS

- A. The Contractor shall be governed by the requirements of the GENERAL PROVISIONS of these specifications. After an item has been approved, no substitution will be permitted except where such substitution is considered by the Engineer to be in the best interest of the Owner.
- B. The Contractor shall notify the Engineer of any changes in electrical characteristics of equipment being installed as opposed to that specified.
- C. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundations, piping, ductwork, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings, and detailing required shall, with the approval of the Engineer, be prepared by the Contractor at the Contractor's own expense.
- D. Where such approved deviation requires a different quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the drawings, with the approval of the Engineer, the Contractor shall furnish and install such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

2.03 FIRESTOPPING

- A. All penetrations through fire barriers shall be firestopped with an approved material that is capable of maintaining the fire resistance rating of the barrier. All firestop sealants shall conform to ASTM E 814, ASTM E 119, UL 1479, UL 2079 CAN/ULC S115, and CAN/ULC S101.
- B. Firestop material shall be latex based, intumescent caulk intended for use for all thru-penetrations with piping, ducts, cable trays, conduit, and cables.
- C. When exposed to high temperatures or fires, the caulk shall expand in volume to quickly close off voids left by melting or burning construction materials. Caulk shall be applied by a standard caulk gun and remain flexible after curing.
- D. Acceptable products shall be limited to Johns Manville "Firetemp-C1;" Hilti "FS-One;" or 3M "CP25WB+." Coordinate with General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

2.04 SMOKE STOPPING

- A. All penetrations through smoke barriers, smoke partitions, or any other surface required to resist the passage of smoke shall be provided with a smoke stop

sealant and/or system that has been independently tested to provide an acceptable smoke seal that will resist the passage of smoke. Smoke stop systems (including product and installation) shall conform to all applicable standards (including but not limited to ASTM, UL and NFPA), as well as all other local, state or federal requirements.

- B. Acceptable manufacturers shall be limited to the manufacturers that may provide firestopping materials/systems (see paragraph 2.03 of this section). Coordinate with the General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

PART 3 - EXECUTION

3.01 SUPERVISION AND COORDINATION

- A. The Contractor shall have competent supervision on the site at all times to layout, check, coordinate and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades, to prevent interference.
- B. Determine the location, size, etc. of all chases, sleeve openings, etc. required for the proper installation of the electrical work and see that such are provided. All chases, sleeves, openings, etc. shall be set prior to erection of new work to prevent delay in the progress of other work or trades.
- C. Conditions and/or situations which prevent the proper installation of any equipment or item where shown on the drawings shall be called to the attention of the Engineer for instructions.
- D. Equipment shall be shipped or fabricated in sections of suitable size for entering the building and being removed from the finished building in the future if necessary.
- E. Fully investigate all peculiarities and space limitations for all materials and equipment.
- F. Outlet, pull and junction boxes and appliances which require operation, examination, adjustment, servicing or maintenance shall be readily accessible.
- G. Take all field measurements necessary for this work and assume responsibility for their accuracy.
- H. Coordinate the electrical work with all sub-contractors. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of electrical equipment. All electrical work shall be installed in proper sequence with other trades without any unnecessary delay.
- I. Make all sub-contractors, suppliers and manufacturers fully aware of all requirements of the Contract.

- J. Coordinate the spacing and arrangement of lighting fixtures, diffusers, and grilles to establish a symmetrical pattern.
- K. Coordinate the rough-in of all electrical work performed under other Divisions of these specifications.
- L. Drawings indicate the approximate locations of outlets, apparatus and equipment. The runs of feeders and branch circuits as shown are schematic. Final routing is governed by structural conditions and other obstructions. This does not mean that the design may be changed; it merely refers to the exact run of a raceway between given points.
- M. The drawings are diagrammatic and indicate the general arrangement of the equipment, the runs of conduit and the manner of connection.
- N. The architectural, structural, mechanical, as well as the electrical drawings, shall be consulted in order to be entirely familiar with conditions to be encountered and special details.
- O. The Contractor shall be solely responsible for the proper arrangement of conduit.
- P. The Engineer shall make all final decisions as to any conditions which require the changing of any work.

3.02 STORAGE AND PROTECTION OF EQUIPMENT AND WORK

- A. All materials and equipment shall be properly and effectively protected by the Contractor during the execution of the work.
- B. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, snow, rain, sleet or dust. Large diameter cables may be stored on reels outside, however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened and made impervious to the elements.
- C. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
- D. All gear and equipment, if delivered to the construction site before the building is under cover and the equipment site prepared shall be warehoused and protected. All gear and equipment shall be covered and protected from the elements and

other damage and shall be stored in a clean, dry, heated atmosphere, under cover at the Contractor's expense.

- E. All gear and equipment delivered to the construction site after the building is under cover shall be protected as described above and in addition shall be provided with auxiliary heat to prevent condensation damage. The gear shall also be protected against damage caused by carelessness of workmen who are installing equipment connected to or adjacent to the above electrical equipment.
- F. Equipment damaged as a result of the above conditions shall be properly repaired at the Contractor's expense or shall be replaced at the Contractor's expense, if, in the opinion of the Engineer the equipment has been damaged to such an extent it cannot operate properly after repairs are made.
- G. All electrical enclosures exposed to construction damages such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs and pipe covering compound splashes, shall be completely covered and protected against damage.
- H. In the event leakage into the building of any foreign material or fluid occurs or may occur, the Contractor shall take all steps as described above to protect any and all equipment.
- I. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape and insulation removed in order to make connections.

3.03 CUTTING AND PATCHING

- A. All cutting of walls, floors, roofs, ceilings and/or partitions for the passage of conduit, etc., and closing up of superfluous openings around them in connection with the work under this contract, including the removal of all debris caused thereby, shall be performed by the Contractor.
- B. All cutting, patching and finishing shall be performed in accordance with the requirements of the respective division of the specification and shall conform to adjacent work, subject to the approval of the Engineer.
- C. Any work already in place that has been disturbed in the execution of the work shall be repaired and restored in harmony with the surrounding work.
- D. Do not cut structural members without approval of the Engineer.
- E. Patching shall be uniform in appearance and shall match with the surrounding surface.

3.04 PENETRATION OF WATERPROOF AND FIREPROOF CONSTRUCTION

- A. Coordinate the work to minimize penetration of waterproof construction including roofs, exterior walls and interior waterproof construction. Where such penetrations are necessary, provide all necessary curbs, sleeves, shields, flashings, pitch pockets, fittings and caulking to make the penetrations absolutely watertight.
- B. Where waterproofing or fireproofing have been removed or damaged in the execution of the work, the Contractor shall have such damage repaired by the respective trades working on the project.
- C. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- D. Seal holes or voids made by penetrations to ensure an effective smoke barrier.
- E. Slots, sleeves and other penetrations in floors, wall or other general construction shall be closed and sealed with an approved firestopping material.
- F. Floor slots and openings shall be closed with 16 gauge (1.6 mm) galvanized steel sheet supported on 1-inch by 1-inch by 1/8-inch (25 mm by 25 mm by 3 mm) structural angle drilled or supported with powder-driven studs into the building structure. Firestop with a layer of firestopping material not less than 1-inch (25 mm) thick which completely fills the opening. The top surface of the firestopping material shall be approximately 1-inch (25 mm) below the finished floor slab.
- G. Openings in walls shall be closed with 16 gauge (1.6 mm) galvanized steel sheet securely attached at the midpoint of the wall thickness and firestopped on both sides of the steel sheet with not less than 1/2-inch (13 mm) thick layer of non-sagging firestopping material to fully cover the opening.
- H. Single or multiple pipes passing through walls and floors shall have the annulus space between pipes or between pipes and structure filled with firestopping material to provide a fire rating equal to the rating of the floors and walls being penetrated. The annulus between exposed conduit and walls or floors in finished spaces shall be filled, sealed, and painted to match adjacent surfaces.
- I. In fire-rated partitions where horizontal separation of opposite-facing electrical boxes is less than 24 inches, provide UL listed firestop around electrical boxes as required to maintain fire rating of wall.

3.05 MANNER OF INSTALLATION

- A. Provide equipment supports consisting of structural racks, hangers, rods, etc.
- B. Equipment supports shall be designed and constructed to safely support and distribute loads evenly over building areas, and withstand stresses to which they may be subjected.

- C. Coordinate the location and installation of supports and sleeves to be set in concrete.
- D. Provide finish metal access doors and frames as indicated or required for access to concealed electrical equipment requiring inspection, adjustment, maintenance, manual operation, etc., or required by code.
- E. In suspended metal pan, lay-in-panel, and accessible tile ceilings, the ceiling element may be used as the access panel.
- F. Access doors in 1-1/2 hour fire-rated construction shall bear the Underwriter's Laboratories "B" label.
- G. Floor-mounted equipment (generators, transformers, starters, control cabinets, etc.) shall be provided with concrete foundations.
- H. Concrete foundations shall be reinforced to suit the loads placed on them and shall be in strict accordance with the equipment manufacturer's recommendations. Concrete materials and methods shall be as specified in Division-3 of these specifications. The Contractor shall refer to this Division to determine specific requirements.
- I. Unless otherwise indicated or required, concrete foundations shall extend 4-inches (100 mm) above the finished floor, at least 3-inches (75 mm) beyond the equipment base in all directions, shall have the top edges chamfered 1" (25 mm) and shall have the same surface finish as the adjacent and surrounding floor. Where equipment weight is such that the floor slab will support the equipment the concrete foundations shall be securely anchored to the floor slab with steel dowels. Properly prepare existing floors: remove paint or dirt, clean and scarify as necessary.
- J. The Contractor shall furnish and set, with proper templates, all anchor bolts and inserts required for the proper attachment of his equipment to the concrete foundations. Anchor bolts shall be of the size and number required by the equipment and/or recommended by the equipment manufacturer and shall be in accordance with the requirements detailed on the drawings and/or specified herein. Anchor bolts shall also be compatible where applicable, with vibration isolation requirements specified for the equipment. Anchor bolts shall be of adequate size and shall engage a steel plate of adequate dimensions cast into the slab.
- K. The drawings indicate the wiring method. The number of current carrying conductors per raceway or cable shall be as indicated. The number of current carrying conductors cannot exceed three (3) per raceway or cable, unless the ampacity adjustment factors of NEC Article 310 are applied.

3.06 CLEANING AND PAINTING

- A. All equipment and conduit shall be thoroughly cleaned of all cutting waste from reaming and tapping. All burrs and other foreign matter shall be removed. Should any part of the system be stopped up by such refuse after the various equipment and apparatus have been accepted, the Contractor shall be required to pay for all labor and materials required to locate and remove the obstruction, and replace and repair all work in any way disturbed thereby. All enclosures, etc., shall be cleaned of all rubbish, plaster, and other debris at the completion of the work.
- B. Paint all exposed metal surfaces, except for galvanized surfaces and extruded aluminum cable and wire duct, of all electrical equipment in mechanical rooms and equipment spaces. Paint all backboards in all telephone and electrical rooms.
- C. Do not paint nameplates or other elements where such application would interfere with operation or maintenance of equipment.
- D. All scratches or marred areas on factory painted equipment shall be touched up to match finish.

3.07 IDENTIFICATION

- A. Equipment (disconnects, panelboards, starters, relays, switches with pilot lights, pushbutton stations, etc.) shall be identified as to its function, equipment, or area served, etc. In finished areas and mechanical rooms and equipment spaces identification shall be engraved phenolic plates with approximate 3/16" (5 mm) high black letters on white background. Equipment connected to the emergency power system shall be provided with phenolic plates utilizing white letters on red background. Plates shall be attached to front of devices with stainless steel, oval head, machine screws. Panelboards and equipment cabinets shall also be identified with stenciled letters, 3/4" (19 mm) high, on inside of cabinet door, colored to contrast with background.
- B. All conduits containing electrical feeders shall be identified with vinyl cloth pipe markers by W.H. Brady or Seton. Labels shall be applied whenever a conduit enters or leaves a switchboard, panelboard, or a junction or pull box, and at each side of penetrations of walls or floors. Provide individual numbers and letters to indicate feeder number and voltage.
- C. All pull box and junction box covers shall be stenciled to indicate voltage, service and/or system. All stenciling shall be clear and legible from a distance of five (5) feet.
- D. No embossed plastic tape markers will be permitted for use in marking equipment.
- E. All underground feeders, branch circuits, ductbanks, etc. shall be identified with a continuous plastic tape equal to Allen Marking Tape. Tape shall be six inches wide, waterproof, chemically resistant, yellow marked "Caution - Buried Electrical Line Below". Tape shall be located approximately midway from grade to top of feeder.

- F. Receptacle Cover Plates: Provide label on front of cover plate unless otherwise noted. Label shall indicate source panel and circuit number. Label shall be a laminated, adhesive backed, peel-off, polyester type label. Label shall be comprised of a polyester base/substrate and a clear polyester top layer/laminate. The label ink shall be printed underneath the clear polyester laminate. Label shall have black lettering on clear background. Label width shall be a nominal 0.47" (12 mm) wide. Basis of design is the TZe labeling tape by Brother Mobile Solutions, Inc. For use with the Brother P-Touch EDGE Series labeling tools.
- G. All identification shall be subject to the approval of the Engineer.

3.08 EXAMINATION OF SITE

- A. The Contractor shall examine the premises prior to submitting his bid and observe the conditions under which the work will be done or other circumstances which will affect the contemplated work. No allowance will be made for any work in connection with any error or negligence on the Contractor's part. No claim for extra compensation will be recognized for difficulties encountered which, in the opinion of the Owner, would have been revealed by proper examination.
- B. If any hazardous materials are found, all work shall stop and the DGS project manager shall be notified ASAP.

3.09 ELECTRICAL DEMOLITION

- A. All demolition of existing electrical equipment, conduit, wiring devices, lighting fixtures, etc. shall be performed under this section of the specification. The areas of demolition are defined on the drawings.
- B. The electrical demolition in the renovation areas indicated on the drawings shall be complete and include all electrical work in the area unless noted otherwise.
- C. Existing electrical systems passing through areas of demolition to serve equipment beyond the demolition areas shall remain in service, or be suitably relocated and restored to normal operation, throughout the demolition and reconstruction of the area. The Contractor shall investigate and identify such equipment prior to demolition.
- D. Provide temporary electrical service to equipment disturbed by the demolition until such time as the permanent service can be restored.
- E. The local power company shall disconnect and remove all equipment and facilities that they own and/or maintain (if needed to be removed). The Contractor shall make and be responsible for all arrangements with the local power company to accomplish removal of their equipment.
- F. Where conduit and wiring to remain are inadvertently damaged or disturbed, cut out and remove damaged portion and all damaged wiring from the source

switchboard, panelboard or pullbox to the destination connection point. Provide new wiring of equal capacity.

- G. Exposed conduit and conduit within accessible ceilings, floors and walls to be demolished shall be removed in its entirety, including all conduit, supports, junction boxes, etc. Conduit concealed within non-accessible ceilings, floors and walls abandoned in place, shall be cut flush with walls and floors, plugged, and the adjacent surface patched to match existing.
- H. Wiring to be demolished shall be removed from both concealed and exposed conduit. No wiring which becomes unused as a result of the Contract shall be abandoned in place.
- I. Equipment specified or indicated to be demolished, shall be removed from the project site and shall not be reused. Equipment required to be temporarily disconnected and relocated shall be carefully removed, stored, cleaned, reinstalled, reconnected and made operational.
- J. All material being disposed of shall be done as required to meet the applicable environmental regulations for all local, state, and federal agencies. Examples include, but are not limited to, light fixture ballasts, fluorescent lamps, and batteries.
- K. Any outages in systems shall be coordinated with the Owner. Where duration of proposed outage cannot be tolerated by the Owner, provide temporary connections as required to maintain service.
- L. Disconnect abandoned outlets and remove devices and wiring back to point of use. Provide blank cover for abandoned outlets.
- M. The contractor shall use care when performing selective building and site demolition. The contractor shall be responsible for damage inclusive of but not limited to: building finishes, lighting (interior and exterior), furniture, structure, site, utilities (above and below ground), mechanical, plumbing, telecommunications and electrical equipment / systems. Should any damage occur or should any remedial work be required, the contractor shall be responsible to repair and or replace the damaged item(s) to the Owner's satisfaction at no additional cost. The contractor shall be responsible for surveying (including contacting Miss Utility), photo documenting and restoring the surrounding work site(s) to the original pre-demolition condition and / or to the Owner's satisfaction upon completion of the work at no additional cost.
- N. Repair adjacent construction and finishes damaged during demolition. Patch all holes left from demolished equipment. Paint surfaces exposed by demolition to match adjacent surfaces.

3.10 CONNECTIONS TO EXISTING WORK

- A. When the work specified hereafter connects to any existing equipment, conduit, wiring, etc., the Contractor shall perform all necessary alterations, cutting, fitting, etc., of the existing work as may be necessary or required to make satisfactory

connections between the new and existing work and shall leave the completed work in a finished and workmanlike condition, to the satisfaction of the Engineer.

- B. When the work specified hereafter or under other Sections or Divisions of the contract necessitates relocation of existing equipment, conduit, wiring, etc., the Contractor shall perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike manner to the satisfaction of the Engineer.
- C. The Contractor is cautioned that all existing electrical systems and life safety systems must remain in service during all phases of construction.
- D. The Contractor shall work in close cooperation with the Owner for any temporary outages.
- E. It is imperative that all interruptions of the electrical service and standby service be kept to an absolute minimum. The Contractor must submit a written request to the Owner for any and all interruptions of the electrical service or the standby service two (2) weeks in advance of the planned outage.

3.11 WORKMANSHIP

- A. All materials and equipment shall be installed and completed in a first class workmanlike manner and in accordance with the best modern methods and practice. Any materials installed which do not present an orderly and reasonably neat or workmanlike appearance shall be removed and replaced when so directed by the Engineer. The removal and replacement of this work shall be done, when directed in writing by the Engineer, at the Contractor's expense.

3.12 REPAIR OF EXISTING PROPERTY

- A. All work shall be carefully laid out in advance, and where cutting, channeling, chasing, trenching, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of raceways, outlet boxes, or other electrical work, this work shall be carefully done, and any damage to building, piping, equipment, or ground shall be properly repaired by skilled mechanics of the trades involved, at no additional cost to the Owner.

3.13 TEMPORARY ELECTRICAL SERVICE

- A. The Contractor shall provide temporary electrical service on the site as is necessary to enable his work and the work of others on the job to proceed and to test the operation of all apparatus, devices, systems which require electrical energy.
- B. The Contractor is responsible for temporary power as may be required for construction or as may be required to maintain critical operations during changeover of feeders or services. The Contractor is responsible for providing all equipment, making all arrangements (including all work needed to submit a

service application to the power company), and making all connections required for temporary power. Provide generators for temporary power if needed.

- C. The Contractor shall disconnect and remove all equipment and facilities required for temporary power at the completion of the project.

3.14 PUNCH-OUT PROCEDURES

A. Preliminary Punch-out:

1. Prior to requesting an inspection from the Owner, Engineer, or Permit Official, the General Contractor or Construction Manager (GC or CM) shall provide a preliminary punch-out of the area in question.
2. Once completed, their punch list shall be supplied to each trade for corrections and completion. The punch list shall also be provided to the Engineer for their use.
3. Upon being informed that the trade contractors have addressed all of the outstanding items, the GC / CM shall backcheck the work and update the punch list.

B. Final Punch-out:

1. Final punch-out by the engineer shall not commence until the GC or CM has exhausted their review and has signed off on all items.
2. A copy of the sign-off shall be provided to the Engineer for their record.
3. Once the above has been completed, the Engineer shall be notified that the work is substantially complete and ready for a final punch-out.

END OF SECTION 16010

PART 1 – GENERAL

1.01 SUMMARY

- A. This section provides a summary of the primary electrical project closeout activities, however, this section does not attempt to address all project closeout requirements. Closeout activities referenced in this section include the following:
 - 1. Testing
 - 2. Start-up
 - 3. Punch-out Procedures
 - 4. Operation and Maintenance Manuals (O & M Manuals)
 - 5. Demonstration and Training
 - 6. Record Documents
 - 7. Close-out Documents
- B. This Section shall not supersede any other close-out section or requirements of the Contract. Refer to other Divisions of the specifications and the General Requirements of the Contract for further instructions.

PART 2 – PRODUCTS

Not Applicable

PART 3 – EXECUTION

3.01 TESTING

- A. The Contractor shall perform systems and equipment inspections and tests as specified in each Division-13 and Division-16 specifications section. Particular attention shall be paid to Division-16 section “Inspections, Testing and Start-up.”
- B. An independent testing firm shall perform systems and equipment inspections and tests as specified in each Division-16 section. Particular attention shall be paid to Division-16 section “Inspections, Testing and Start-up.”

3.02 START-UP

- A. The Contractor shall perform start-up on each piece of electrical equipment as specified in each section of Division-16.
- B. Where indicated in each section of Division-16, the services of a factory authorized and certified technician shall be required to perform the equipment start-up. Start-up by any other organization other than as required by the manufacturer is unacceptable.
- C. Start-up reports shall be provided for all equipment and be included in the final O & M Manuals.

3.03 PUNCH-OUT PROCEDURES

A. Preliminary Punch-out:

1. Prior to requesting an inspection from the Owner, Engineer, or Permit Official, the General Contractor or Construction Manager (GC or CM) shall provide a preliminary punch-out of the area in question.
2. Once completed, their punch list shall be supplied to each trade for corrections and completion. The punch list shall also be provided to the Engineer for their use.
3. Upon being informed that the trade contractors have addressed all of the outstanding items, the GC / CM shall backcheck the work and update the punch list.

B. Final Punch-out:

1. Final punch-out by the engineer shall not commence until the GC or CM has exhausted their review and has signed off on all items.
2. A copy of the sign-off shall be provided to the Engineer for their record.
3. Once the above has been completed, the Engineer shall be notified that the work is substantially complete and ready for a final punch-out.

C. Upon completion of any and all punch lists the contractor shall provide an item by item sign-off indicating the date and who completed the item. The sign-off shall be submitted to the A/E and owner before final payment is processed. Should the contractor disagree with any item, they shall provide a written exception giving reason for review.

3.04 OPERATION AND MAINTENANCE MANUALS

A. Submit Operation and Maintenance Manuals in three-ring binders with each section separated by tab dividers. Include protective plastic sleeves for any software or folded large documents submitted.

B. At a minimum, the manual shall contain the following:

1. Test results for all testing conducted in accordance with Division-16 Section, "Inspections, Testing and Start-up".
2. List of materials and equipment with name and address of vendor.
3. List of lamps, fuses (style and ampere rating), overload heaters, and other expendable equipment and devices with type, size or ordering description with name and address of vendor.
4. Operating, maintenance, and installation instructions for all systems and components with name and address of vendor and servicing supplier.
5. A certificate of approval from the Electrical Inspector.
6. A final copy of the approved coordination, short circuit and arc flash study.
7. Final copies of shop drawings and submittals.

8. Manufacturer's guarantees and warranties.
9. A full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.

- C. The O & M Manuals shall be submitted to the A/E for review of general conformance.

3.05 DEMONSTRATION AND TRAINING

- A. Upon completion of work, instruct the owner's representative in the proper operation and maintenance of each electrical system in accordance with applicable specification sections.
- B. Instructions shall be given by persons expert in the operation and maintenance of each system / equipment.
- C. Prepare statement(s) for signing by Owner's representative indicating the date of completion of instructions and hours expended. Furnish copies of signed statements to the A/E.

3.06 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of electrical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible electrical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the owner upon completion. If requested, the electronic CADD documents shall be up-loaded to the owner's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be

compatible with the owner's preferred version of AutoCad. Coordinate with the owner before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.

- D. Computer (CADD) files of electrical drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

3.07 CLOSEOUT DOCUMENTS

- A. Prior to Substantial Completion and /or Final Payment, the Contractor shall prepare and submit the following:
 - 1. Final punch lists indicating completion of all items.
 - 2. All record drawings.
 - 3. All record specifications.
 - 4. Operation and Maintenance Manuals.
 - 5. Complete final cleaning.
 - 6. Remove temporary facilities and complete site restoration.

END OF SECTION 16020

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The intent of the inspection, testing, and check-out work specified herein is to insure that all electrical workmanship and equipment, whether Owner furnished or Contractor furnished, is installed and performs in accordance with the Contract Documents, manufacturer's instructions and all applicable codes and requirements. Also, it is intended to insure the following:
1. Equipment has not been subjected to damage during shipment or installation.
 2. Equipment is in accordance with the specifications.
 3. A bench mark is established for routine maintenance and troubleshooting.
 4. Successful start-up without last minute interruptions and delays.
 5. Each system component is installed satisfactorily and will perform its function reliably throughout its life and the life of the overall system.
- B. Testing requirements in other sections of this Specification are intended to compliment and not supersede nor be superseded by this Section.

1.02 RELATED SECTIONS

- A. Division-1 Section – Contract Closeout.
- B. Division-1 Section - Quality Control.
- C. Division-1 Section – Final Cleaning.
- D. Division-16 - Electrical Specifications.

1.03 REFERENCES

- A. American National Standards Institute (ANSI):
1. ANSI C2, National Electrical Safety Code
 2. ANSI Z244-1, American National Standard for Personnel Protection
- B. American Society of Testing and Materials (ASTM).
- C. Institute of Electrical and Electronic Engineers (IEEE).
- D. Insulated Cable Engineers Association (ICEA).
- E. International Electrical Testing Association (NETA).
- F. National Electrical Manufacturer's Association (NEMA).
- G. National Fire Protection Association (NFPA):

1. ANSI/NFPA 70, National Electrical Code
2. ANSI/NFPA 70B, Electrical Equipment Maintenance
3. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces

H. Occupational Safety and Health Administration (OSHA).

I. State and Local Codes and Ordinances.

1.04 SUBMITTALS

- A. Provide resumes for personnel conducting tests and evidence of the testing firm's qualifications, accreditation, and experience.
- B. Provide a list of test equipment to be utilized including the manufacturer's name, model number, serial number, accuracy, and last date of calibration.
- C. Provide industry standards or guide specifications used in lieu of National Standards.
- D. Provide testing procedures and schedules.

1.05 TESTING FIRM

- A. When an independent testing firm is utilized, the following shall apply. The testing firm shall be a competent, independent electrical equipment testing laboratory or organization. The testing firm shall not be a subsidiary, division, nor department of either the installing Contractor or the manufacturer of the equipment materials or systems being inspected and tested. The testing firm shall be a fully accredited member of the International Electrical Testing Association (NETA) and have the specialized experience and skill in the supervision and performance of all inspection and testing specified herein.

1.06 TEST INSTRUMENT CALIBRATION

- A. The testing firm or contractor shall have a calibration program which assures that all applicable test instrumentation is maintained within rated accuracy.
- B. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
- C. Instruments shall be calibrated in accordance with the following frequency schedule:
 1. Field instruments, analog: six (6) months.
 2. Field instruments, digital: twelve (12) months.
 3. Laboratory instruments: 12 months.
 4. Leased specialty equipment: 12 months.

- D. Calibration labels shall be visible on all equipment and shall have a date of calibration and due date. Calibration records shall be available for review by the Owner.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 COORDINATION

- A. Provide all necessary supervision and labor, materials, tools, test instruments and other equipment or services required to inspect, test, adjust, set, calibrate, functionally and operationally check all work and equipment.
- B. When an independent testing firm is utilized, provide a set of contract documents to the testing firm.
- C. When an independent testing firm is utilized, provide a copy of the approved short-circuit and protective device coordination study to the testing firm.
- D. Provide the testing firm a set of approved submittals and shop drawings for the equipment to be tested by the testing firm.
- E. Prepare procedures and schedules for all inspections, tests, settings and calibrations specified or otherwise required. The procedures must provide specific instructions for the checking and testing of each component in addition to the system functional checks. All procedures submitted shall include proposed job safety rules.
- F. Provide a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements. The Owner shall approve all sources of electrical power for testing.
- G. Notify the Owner prior to the commencement of any testing.

3.02 INSPECTIONS AND TESTS

- A. Equipment purchased by the Contractor or purchased by the Owner but installed by the Contractor shall be inspected and tested to determine its condition.
- B. The inspections, tests and checks described herein shall not be considered as complete and all inclusive. Additional normal standard construction (and sometimes repetitive) checks and tests shall be provided as necessary throughout the project, prior to final acceptance by the Owner.

- C. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, faulty, or requiring repairs shall be reported to the Owner. Corrective action may require prior approval.
- D. Perform routine insulation resistance, continuity and phase rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
- E. An independent testing firm shall provide NETA ATS testing of the following systems and equipment.
 - 1. Medium voltage cables and terminations
 - 2. Medium voltage transformers
 - 3. Grounding systems
 - 4. Generator sets & Fuel Tank and associated HVAC dampers (tested concurrently)
 - 5. Automatic transfer switches (test with Generator).
 - 6. Load Bank (test with Generator).
 - 7. Low voltage circuit breakers rated 400 amperes and higher
 - 8. Fire alarm system.
- F. At the option of the Contractor, either an independent testing firm or the Contractor shall provide NETA ATS visual and mechanical inspections of the following systems and equipment.
 - 1. Panelboards
 - 2. Low voltage wiring (600 volt and below)
 - 3. Molded case circuit breakers rated less than 400 amperes
 - 4. Motor control
 - 5. Duct banks prior to backfill.
 - 6. Handholes.
 - 7. Grounding prior to backfill / cover.
- G. All circuit breakers and protective devices shall be set and tested at the settings specified in the approved protective device coordination study. All fuses shall be selected and installed in accordance with the approved coordination study.
- H. The rotation of all motors shall be checked and corrective action shall be taken where necessary to obtain correct rotation.
- I. Engagement of an independent testing firm in no way relieves the Contractor of the responsibility for the performance of the many and varied tests, checkouts, and inspections required during the various stages of construction.

3.03 CERTIFICATION

- A. Provide certified test reports. Test reports shall meet the criteria specified in OSHA Regulation Part 1907, "Accreditation of Testing Laboratories". The certification shall attest to the fact that the electrical installation has been installed and tested in accordance with the applicable National Standards or,

where no National Standard exists, the applicable industry standard or guide specification for the equipment involved.

- B. The following information shall be included in the test reports.
 - 1. Description of equipment tested (manufacturer, model number, serial number).
 - 2. Description of test and standards used.
 - 3. Description of test equipment.
 - 4. Test results with pass/fail criteria.
 - 5. Conclusions and recommendations.
 - 6. Names of personnel conducting the test.
- C. When testing is provided by an independent testing firm, the report shall be signed by a Registered Professional Engineer.
- D. Provide three (3) copies of the complete test report no later than thirty (30) days following completion of the tests.

END OF SECTION 16051

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall engage the services of a qualified professional engineer to perform a short circuit and protective device coordination study and an arc flash hazard analysis. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study. The study shall be performed in strict accordance with these specifications.
- B. The study shall include all portions of the electrical distribution system from the utility overcurrent device to the service entrance equipment at each building on campus.

PART 2 - PRODUCTS

2.01 SHORT CIRCUIT STUDY

- A. The Contractor shall provide a short circuit study for the electrical distribution system. The study shall include the calculation of single phase bolted fault values and phase to ground fault values at every point of application of a protective device on the system. Momentary and interrupting duty values shall be calculated.
- B. The short circuit calculations shall be performed by a computer program. Provide a computer generated single line diagram showing calculated and rated fault levels for each piece of electrical equipment.
- C. The short circuit study report must include a complete index of fault bus identifications. A system diagram indicating system configuration and the fault bus locations shall be provided in the study.
- D. Provide a complete printout of the results of the calculations.
- E. Momentary duty fault values shall be tabulated for both line to line and phase to ground faults including: bus identification, bus L-L voltage, symmetrical fault current values, symmetrical fault kVA values, and X/R ratio at each fault bus.
- F. Interrupting duty fault values shall be tabulated for both line to line and phase to ground faults including: bus values, symmetrical fault kVA values, X/R ratio at each fault bus, asymmetry factor at each fault bus, and the associated asymmetrical fault value at the bus.
- G. Manufacturer's published interrupting/withstand capabilities shall be compared to calculated fault current values to determine acceptability of each protective device installed on the system. A tabulation shall be provided detailing the comparison.
- H. The short circuit study shall report any deficiencies in interrupting capabilities and include recommendations for correcting such deficiencies.

2.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. The Contractor shall provide a protective device coordination study for all protective devices installed on the electrical distribution system.
- B. The coordination study shall begin with the first upstream utility protective device and continue down through the service entrance equipment at each building.
- C. Time-current coordination curve sheets shall be developed on log-log paper utilizing manufacturer's published time-current characteristics. Key coordination elements shall be plotted to demonstrate the level of coordination provided.
- D. Transformer damage characteristics as specified in American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI and IEEE) guidelines and inrush points shall be plotted to demonstrate the level of protection provided. Cable insulation withstand curves shall also be plotted to demonstrate protection provided.
- E. Each curve sheet shall have a single line diagram indicating the portion of the system being plotted.
- F. Each curve sheet shall be accompanied by a detailed narrative explaining the coordination provided, and any compromises made between protection and selectivity.
- G. The coordination study report shall provide complete tabulations of all protective devices, ratings and settings. Recommendations shall be provided to improve coordination where necessary.

2.03 ARC FLASH HAZARD ANALYSIS

- A. Provide arc flash hazard calculations for all electrical distribution equipment identified in NEC Article 110.16, Flash Protection.
- B. Provide arc flash hazard calculations per IEEE-1584. Calculations shall provide the flash protection boundary (ft.), arc flash hazard category and Available Incident Energy for all electrical distribution system equipment included in the Arc Flash Hazard Analysis. Also provide Bolted Fault Current.
- C. Provide an arc flash hazard warning label on all electrical distribution system equipment included in the Arc Flash Hazard Analysis. The label shall comply with ANSI Z535.4-1998, Product Safety Signs and Labels. The label shall include, but not be limited to, the flash protection boundary, Available Incident Energy, and Bolted Fault Current. Provide labels and calculations for all 240V equipment. No exceptions shall be made for 240V equipment. Provide weatherproof labels where appropriate.

PART 3 - EXECUTION

3.01 REPORT

- A. **The short circuit and coordination study shall be completed prior to releasing for manufacture of all fused switches, panelboards, transfer switches, circuit breakers and other equipment with overcurrent protection.**
- B. Six (6) copies of a bound report shall be submitted for review and approval at the completion of the short circuit and coordination study. The report shall contain all of the items required by these specifications. The report must be submitted prior to the delivery of any distribution equipment submittals. Submittal reviews of distribution equipment shall be withheld until the report is received, reviewed, and approved.
- C. Time-current coordination curve sheets may be reduced to 8-1/2 x 11 size for inclusion in the report. However, full size curve sheets shall be provided, not necessarily bound, with each copy of the report.
- D. The Contractor shall warrant that errors and omissions in the study or report shall be corrected without charge to the Owner when so found within twelve (12) months from acceptance of the first report.
- E. Copies of the approved study shall be included in the manuals specified in Division-16 Section, "Basic Electrical Materials and Methods."

END OF SECTION 16055

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies general grounding and bonding requirements for all electrical installations.

1.02 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this Section.

1.03 SUMMARY

- A. All systems, circuits and equipment shall be grounded and bonded in accordance with Article 250 of the National Electrical Code and the requirements of these Specifications and the Drawings.

1.04 SUBMITTALS

- A. In accordance with section Submittals and Division-16 Section, "Basic Electrical Materials and Methods", the following shall be furnished:
 - 1. Test Reports: Certified test reports of ground resistance.
 - 2. Certifications: Two weeks prior to final inspection, deliver to the Owner six (6) copies of the certification that the materials and installation are in accordance with the drawings and specifications and have been properly installed.
 - 3. Provide product data for all grounding and bonding components and accessories.

1.05 QUALITY ASSURANCE

- A. All grounding components and accessories shall comply with and shall be installed in accordance with NFPA 70, Article 250 of the National Electrical Code, and applicable sections of UL Std 467, "Electrical Grounding and Bonding Equipment", and UL Std 869, "Electrical Service Equipment".
- B. Grounding and bonding components and accessories shall be UL listed and labeled for the specific application for which they are being used.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

- A. Provide electrical grounding and bonding components and accessories including, but not limited to, cables and wires, connectors, terminals, jumpers and surge arresters as required for a complete installation.
- B. Where more than one product meets the intended requirements, selection shall be at the discretion of the Installer.

- C. Provide electrical insulating tape, heat-shrinkable tubing, welding materials, straps and jumpers as recommended by manufacturer's written instructions and in accordance with standard industry practices.
- D. All below grade grounding connections shall be exothermic welds and splices and shall be by Cald weld or equal. All materials shall be supplied by one manufacturer to ensure compatibility.

2.02 GROUNDING CONDUCTORS

- A. Provide a grounding conductor with green insulation.
- B. General purpose insulating grounding conductors have insulation types as identified by the NEC and tested, certified, and labeled in accordance with UL Standards.
- C. Non-insulated grounding conductors shall be bare, soft drawn, single or multiple strand annealed copper in wire gauges or sizes as shown on the drawings or consistent with the requirements of NEC Article 250.

2.03 GROUND RODS

- A. Ground rods shall be copper clad, solid steel round bars, 3/4 inches (19 mm) in diameter and 10 feet (3 m) in length.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

- A. All equipment, conduit systems, raceway systems, metallic enclosures of electrical devices, transformer frames and equipment, wiring devices and all metallic non-current carrying devices, etc. shall be completely grounded in accordance with the requirements of the National Electrical Code (latest edition).
- B. Grounding conductors shall be installed within conduit and shall be sized in accordance with NEC Article 250.
- C. Continuity of rigid steel raceways shall be insured by conduit hubs. All grounded neutral conductors shall be continuously identified. All grounding and bonding connections shall be solderless. All grounding and bonding connections to structural steel shall be exothermic welds. Ground fittings at water system connections shall have rigid clamp jaws. Perforated grounding straps shall not be acceptable.
- D. The secondary neutral conductor of transformers shall be continuous, identified throughout and grounded in an approved manner to the grounding electrode system. Conductor used to ground neutral conductor shall be sized in accordance with NEC Article 250.

- E. Provide insulated grounding conductors for all feeders and branch circuits. Provide grounding blocks, terminals, etc. for connection of ground wires in all distribution equipment, outlets, junction boxes and utilization equipment.
- F. Provide bonding for all metal piping systems and structural steel. Provide braided copper jumpers at valves, equipment, etc. Bonding shall be in accordance with NEC Article 250.
- G. All grounding wire, lugs, jumpers and bus shall be copper except as specifically approved elsewhere in these Specifications.
- H. Where parallel feeders are used, each raceway shall contain an equipment ground conductor sized in accordance with NEC Article 250 for the combined parallel circuit amperage.
- I. Grounding electrode conductor shall be continuous and no splicing shall be allowed. Equipment grounding conductor splices shall be permitted in device boxes and pulling points, but should be minimized to keep ground resistance as low as possible.
- J. Receptacles shall be bonded to their outlet boxes with #12 copper straps. Straps may be omitted if self-grounding devices are utilized.

3.02 TESTING

- A. The ground resistance at the Main Service Entrance ATS ground buses shall not exceed 10 ohms.
- B. The ground resistance at the Generator Wye Connection Ground connection shall not exceed 10 ohms.
- C. The ground resistance at the Pad Mount Transformer Secondary Wye Ground Connections shall not exceed 10 ohms.
- D. Certified test results shall be provided in accordance with the requirements of Division-16 Section, "Inspections, Testing and Start-up" of these Specifications.

END OF SECTION 16060

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this Section.

1.02 SUMMARY

- A. Support all raceways, enclosures, cabinets, boxes, and related electrical equipment from the building structure as required by the NEC and as described in these Specifications.
- B. Support all lighting fixtures as required by the NEC and as described in these Specifications.

1.03 SUBMITTALS

- A. Provide product data for each type of manufactured supporting device.
- B. Provide shop drawings for each type of fabricated supporting device.

1.04 QUALITY ASSURANCE

- A. All components and the installation of all components shall comply with NFPA 70, "National Electrical Code," requirements.
- B. All supporting devices shall be listed and labeled by UL, ETL, CSA or a Nationally Recognized Testing Laboratory (NRTL).
- C. Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports and equipment mounting.

PART 2 - PRODUCTS

2.01 PROHIBITED MATERIALS

- A. Nails, wires, perforated tape or plumber's tape are unacceptable for supporting or securing conduits.

2.02 MANUFACTURED SUPPORTING DEVICES

- A. Supporting devices shall comply with manufacturer's standard design and construction, fabricated from standard materials in accordance with published product information.
- B. Supporting devices shall be protected with a zinc coating or with a similar corrosion resistant coating or treatment. Devices for use outdoors shall be hot-dip galvanized.

- C. Raceways shall be supported using clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- D. Steel channels and associated support rods shall be selected to accommodate weight of associated raceway and wire.
- E. Anchors shall be provided of adequate size to support the load, and shall be compatible with the construction method encountered. Anchors shall be expansion or toggle bolt type.

2.03 FABRICATED SUPPORTING DEVICES

- A. Pipe sleeves shall be fabricated from galvanized sheet steel or Schedule 40 galvanized steel pipe.
- B. Sheet steel sleeves shall be round tube closed with snaplock, joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge steel: 3" (75 mm) and smaller, 20 gauge (1.0 mm); 4" to 6" (100 mm to 150 mm), 16 gauge (1.6 mm); over 6" (150 mm), 14 gauge (2.0 mm).
- C. Steel brackets shall be fabricated from angles, channels and other standard shapes. Brackets shall be assembled using welds and/or machine bolts to form a rigid assembly.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instruction and following recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Install supports within maximum spacing indicated by NEC or on drawings.
- D. Individual conduits shall be secured with steel pipe straps or lay-in pipe hangers.
- E. Multiple runs of suspended conduit shall be supported from trapeze style hangers.
- F. Multiple runs of conduit on ceiling or wall surfaces shall be mounted on flush or surface steel channels.
- G. Ceiling support wires shall not be used for support of conduits.

- H. Lighting fixtures shall be supported as recommended by the manufacturer. Fixtures shall be secured to the building's structure.
- I. Raceway supports shall be adequate to carry present and future load multiplied by a safety factor of at least four. In no case shall a support strength of less than 200 pounds (1380 kPa) be used.
- J. Manufactured watertight and fire-rated seals shall be provided for sealing conduits and cables passing through sleeves in floors and fire-rated walls. Seals shall be fire-resistant rubber plugs or other materials specifically designed to provide a watertight seal and a UL listed fire-resistant rating which meets or exceeds the rating of the floor or wall.
- K. Provide vibration isolators between enclosures of all vibration producing equipment, transformers, etc., and their supports or floor. Isolators shall be Mason Industrial type NK neoprene and cork sandwich or equal.
- L. Supports are required within 3 feet (900 mm) of each outlet box, junction box, device box, cabinet, conduit body or other tubing terminations.
- M. All junction boxes shall be supported from structure.

END OF SECTION 16070

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. The Contractor shall provide, install and terminate all wires and cables for power, lighting, signal, control and related systems rated 600 volts and less.

1.03 SUBMITTALS

- A. Submit product data for electrical wires, cables and connectors.

1.04 QUALITY ASSURANCE

- A. All wires, cables and connectors and the installation of wires, cables and connectors shall comply with the following standards:
 - 1. NFPA 70 "National Electrical Code."
 - 2. UL Standards pertaining to wires and cables:
 - a. UL Std 44, Rubber Insulated Wires and Cables
 - b. UL Std 83, Thermoplastic - Insulated Wires and Cables
 - c. UL Std 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL Std 486B for Use with Copper or Aluminum
 - d. UL Std 854, Service Entrance Cable
 - 3. Applicable NEMA Standards pertaining to wires and cables.
 - 4. Applicable IEEE Standards pertaining to wires and cables.
- B. Wires, cables and connectors shall be listed and labeled by UL.

PART 2 - PRODUCTS

2.01 WIRES AND CABLES

- A. All wiring #14 and larger shall be soft drawn copper, 98 percent conductivity, 600 volt insulation, type THHN/THWN.
- B. All wiring connections to lighting fixtures shall have insulation suitable for the temperatures to be encountered in accordance with the NEC.
- C. All wiring #8 and larger for feeders and branch circuits shall be stranded.
- D. Minimum wire sizes shall be #12 for power and lighting circuits and #14 for control circuits unless otherwise noted.

- E. All wiring shall have identification markings along the outer covering denoting conductor size, type of insulation, and manufacturer's trade name. All wiring shall be color coded as follows:

<u>PHASE</u>	<u>120/240 VOLTS</u>
A	Black
B	Red
Neutral	White
Ground	Green

- F. Wiring in sizes up to #8 shall have colored insulation, wiring in sizes #6 and larger shall be coded by colored tape applied no more than 6 inches (150 mm) from each termination and spanning a minimum length of 6 inches (150 mm) of insulation.

PART 3 - EXECUTION

3.01 WIRING METHODS

- A. Wiring shall not be installed until building is under roof.
- B. All wiring for lighting and power circuits shall be sized as follows unless otherwise indicated:

<u>120 Volt, 20A Branch Circuit Length</u>	<u>Wire Size</u>
0-75' (0-22.5 m).....	#12
75-150' (22.5-45 m).....	#10
Over 150' (Over 45 m).....	# 8

In accordance with the above where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, it is the Contractor's responsibility to insure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

- C. Wire pulling compounds shall be polywater or equivalent. The use of oils and greases shall not be permitted.
- D. All field-installed control wire and cable terminating in panelboards, junction boxes, etc. shall be identified with pre-stamped tubular type markers or pressure sensitive linen labels covered with clear heat shrinkable tubing. Labels shall indicate circuit numbers, terminal numbers, etc. of each conductor. The identification labels shall be as manufactured by the W.H. Brady Company, Tyton, or equivalent.
- E. No conductors shall be installed in raceways before the raceway system is properly installed and all work on the building which is liable to injure the

conductors has been completed. Immediately before installing the conductors, the raceway, fittings and boxes shall be thoroughly cleaned and dried.

- G. The sharing of the neutral conductor for branch circuits is prohibited.
- H. Conductors shall be continuous between cabinets, outlets and/or junction boxes; no splices or taps shall be made within the raceway itself. Under no circumstances shall feeder conductors be spliced.
- I. At least six inches (150 mm) of free conductors shall be left at each outlet, cabinet, junction box, etc. where they are connected or spliced.
- J. Wiring devices shall not be used as splices; pigtails (line, neutral and grounding) from circuit wiring shall be provided to allow removal of the device without opening the circuit.
- K. Wiring in cabinets shall be neatly laced or tied.
- L. Provide a grounded circuit conductor (neutral) to all wall switch locations.

3.02 TESTING

- A. Feeders shall be checked using a megohm tester to determine the insulation resistance levels prior to energizing.
- B. Branch circuits shall be tested to ensure electrical continuity and to ensure the system is free of short-circuits.
- C. Provide a report indicating test results.

END OF SECTION 16120

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes:

1. Medium Voltage Cable
2. Cable Terminations.
3. Refer to Division 16 - Overhead Electrical Power Systems - for additional info on overhead medium voltage conductors.

1.02 CODES AND STANDARDS

A. The latest editions of the following codes and standards shall govern work performed under this section:

1. ANSI/IEEE C2 - National Electrical Safety Code
2. ANSI/NFPA 70 - National Electrical Code
3. IEEE 48 - Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations
4. NEMA WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
5. UL 1072
6. ICEA (IPCEA) S-68-516

1.03 SUBMITTALS

A. Product Data: Provide for cable, terminations, and accessories.

B. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at thirty (30) second intervals at maximum voltage.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.04 PROJECT RECORD DOCUMENTS

A. Accurately record actual sizes and locations of cables.

1.05 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include instructions for testing and cleaning cable and accessories.

1.06 QUALIFICATION

- A. Installer: Company specializing in installing Products specified in this Section with a minimum three (3) years documented experience.

1.07 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 and ANSI/IEEE C2 as applicable.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose, specified and shown.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site.
- B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.
- C. Store and protect in accordance with manufacturer's instructions.
- D. Protect from weather. Provide adequate ventilation to prevent condensation.

1.09 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of cable bank prior to rough-in.
- C. Cable routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to the following:

- 1. Okonite
- 2. Pirelli Cable Corporation
- 3. Rome

2.02 MEDIUM VOLTAGE CABLE

- A. Description: NEMA WC 8; ethylene propylene rubber (EPR) insulated cable, single conductor, UL listed type MV-105.
- B. Temperature Rating: 221°F (105°C) continuous, wet and dry locations.
- C. Voltage: 15 kV, grounded as appropriate for project conditions.
- D. Conductor: Annealed copper, Class B stranded.
- E. Conductor Shield: Free stripping extruded layer of semi-conducting EPR thermosetting compound and inseparably bonded to the overlying insulation.
- F. Insulation: EPR, 133%, 220 mils minimum thickness.
- G. Insulation Shield: Free stripping extruded layer of semi-conducting EPR thermosetting compound.
- H. Metallic Shield: Non-magnetic uncoated copper tape applied in a helical pattern over the extruded insulation shield with a minimum overlap of 12.5 percent.
- I. Jacket: PVC, 80 mils minimum thickness.
- J. Armor: None.
- K. Armor Jacket: None.
- L. All cable shall be marked with gauge and insulation type on 24" (600 mm) centers. All cable shall be delivered to the job site on original manufacturer's spools bearing the UL label.
- M. Tests shall be conducted at the factory on each reel of cable. The results shall be documented and certified by the cable manufacturer and test reports shall be indexed to specific cable reels. One (1) copy of the test data shall be submitted to the Project Engineer. A copy of the test data shall be shipped with the reel. Factory tests shall include:
 - 1. Conductor DC resistance
 - 2. Shield resistance
 - 3. Insulation resistance
 - 4. Corona discharge
 - 5. Water block
- N. Cables shall be manufactured utilizing a triple tandem extrusion process.

2.03 EPR SPLICES AND TERMINATIONS

A. Splices:

1. Conductor Splices: Compression type connectors.
2. Insulation and Shield Splices: Factory-engineered kits designed to rebuild the primary cable insulation, shielding and grounding systems, and outer jacket equivalent to that of the original cable.
3. Splices shall be of a uniform cross-section, heat-shrinkable polymeric construction utilizing a stress control tube, high dielectric strength insulating layers and a sealant lined outer jacket.
4. When assembled on cable, splices shall be capable of passing the electrical test requirements of IEEE-404 and the water immersion tests of ANSI C119.1-1986.
5. Splices shall be as manufactured by Raychem Corporation or approved equivalent.

B. Medium Voltage Terminations:

1. Terminate conductors using separable elbow connections unless noted otherwise.
 - a. Separable elbow connectors shall be provided by Cooper or approved equivalent.
 - b. Separable Elbow connectors shall be rated 200A, shall be load break type, and shall adhere to IEEE 386 standards.
2. Terminate insulation and shield using factory-engineered kits designed specifically for each cable type. Kits shall consist of heat-shrinkable stress control and outer non-tracking insulation tubing.
3. Termination kits shall meet or exceed all rating requirements of IEEE-48 for Class I terminations and the test sequence prescribed by IEEE-404.
4. Terminations shall be as manufactured by Raychem Corporation or approved equivalent.

2.04 FIREPROOFING

- A. Provide tape fabricated of flexible, conformable fabric of organic composition coated on one side with flame retardant elastomer. The tape shall be arc-proof, flameproof, self-extinguishing and shall not support combustion. Tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus. Tape shall be resistant to sunlight and ultraviolet light. Finished application shall withstand 200 ampere arc for not less than thirty (30) seconds. Provide securing tape fabricated of glass cloth electrical tape not less than 7 mils thick and 3/4 inch (19 mm) wide.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that conduits or duct is ready to receive cable. The entire conduit system, or portion thereof, shall be complete between terminations before installing cable.

3.02 PREPARATION

- A. Use swab to clean conduits and ducts before pulling cables.

3.03 INSTALLATION

- A. Install cable and accessories in accordance with manufacturer's instructions.
- B. Avoid abrasion and other damage to cables during installation.
- C. Use specified lubricants and manufacturer recommended pulling equipment.
- D. Do not exceed cable pulling tensions and side-wall pressures. During cable installation, minimum bending radius shall not be less than twelve (12) times the cable outer diameter or the minimum dictated by the manufacturer or applicable standards, whichever is greater.
- E. Ground cable shield at each termination and splice.
- F. Install cables in handholes along wall providing longest route.
- G. Arrange cable in handholes to avoid interference with duct entrances. Support cables in handholes at intervals no greater than 6 feet (1800 mm).
- H. Fireproof cables in handholes using fireproofing tape in half-lapped wrapping. Extend fireproofing one inch (25 mm) into conduit or duct.
- I. In each handhole, loop conductors once around the handhole prior to exiting.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division-16 Section, Inspections, Testing and Start-up.

3.05 PROTECTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION 16124

SECTION 16125 - OVERHEAD ELECTRICAL POWER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes medium-voltage, overhead electrical power distribution, and the following:
 - 1. Conductors, connectors, and splices.
 - 2. Wood poles.
 - 3. Hardware and accessories.
 - 4. Surge arresters.

1.03 DEFINITIONS

- A. BIL: Basic impulse level, stated in kilovolts.
- B. HDPE: High-density polyethylene.
- C. RUS: Department of Agriculture, Rural Utilities Service.
- D. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.
 - 1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
 - 2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.
- E. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.

1.04 SUBMITTALS

- A. Product Data: For the following:

1. Conductors.
 2. Poles.
 3. Insulators.
 4. Surge arresters.
- B. Qualification Data: For manufacturer and for installer.
- C. Material Inspection Reports: From a qualified independent inspection agency indicating compliance of wood poles with requirements indicated. RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.
- D. Material Certificates: For the following items, signed by manufacturers:
1. Wood poles.
- E. Listing Documentation: Indicate products comply with RUS listing requirements specified in "Quality Assurance" Article.
- F. Field quality-control test reports.
- G. Source Quality-Control Test Reports: Factory inspection reports of wood poles.

1.05 QUALITY ASSURANCE

- A. Inspection Agency Qualifications for Pole Inspection: An independent agency, acceptable to authorities having jurisdiction, qualified to conduct inspections indicated.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Treatment Technician Qualifications for Field Treatment of Wood Poles: Certified by authorities having jurisdiction over environmental protection at the location of Project for field application of chemicals required.
- D. Electrical Components Normally Covered by Listing and Labeling Services: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

- F. Comply with IEEE C2, except where stricter requirements are indicated or where local requirements that are stricter apply.
- G. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for heavy line loading, unless otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Wood Pole Storage and Handling: Comply with ANSI O5.1. Do not use pointed handling tools capable of producing indentations greater than 1 inch (25 mm).

1.07 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than two weeks in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.

1.08 COORDINATION

- A. Coordinate with utility supplying electricity to lines specified in this Section, and make final connections. Coordinate all work with Potomac Edison.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 CONDUCTORS, CONNECTORS, AND SPLICES

- A. Available Manufacturers - Conductors:
 - 1. AFC Cable Systems.
 - 2. Alcan Cable Co.

3. BICC Cables Company.
4. Brugg Telecom Inc.
5. Florida Wire & Cable, Inc.
6. General Wire & Cable Co.
7. Hendrix Wire and Cable Inc.
8. Kerite Company (The); Innovation Systems Inc.
9. King Wire Inc.
10. Nokia Cables USA Inc.
11. Northern Lights Cable, Inc.
12. Okonite Company (The).
13. Rome Cable Corp.
14. Southwire Company.

B. Available Manufacturers - Connectors and Splices:

1. AB Chance Co.; Hubbell, Inc.
2. Connector Manufacturing Co.
3. Cooper Power Systems.
4. Hubbell, Inc.; Anderson Electrical Products, Inc.
5. Hubbell, Inc.; Fargo Manufacturing Company.

C. Medium-Voltage Line Conductors: Bare, Soft-drawn copper (CU), complying with ASTM B 3 and ASTM B 8.

1. Conductor Covering: Refer to Medium Voltage Conductors specification for insulated cables.

D. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:

1. Copper to Copper: Copper alloy, complying with UL 486A.
2. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486B.
3. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486B.
4. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, soft-drawn copper stirrups. Listed for the combination of materials being connected.
5. Splices under Tension: Compression type with strength exceeding the conductors spliced.
6. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Division 26 Section "Medium-Voltage Cables."

2.03 WOOD POLES

A. Available Manufacturers:

1. Bell Lumber & Pole Co.
 2. B. J. Carney & Co., Ltd.
 3. Brown Wood Preserving Co.
 4. GRA Services International, Inc.
 5. J. H. Baxter & Co.
 6. Koppers Industries, Inc.
 7. McFarland Cascade.
 8. Okonite Company (The).
 9. Taylor Lumber & Treating.
 10. Western Red Cedar Lumber Association.
- B. Description: Wood poles comply with ANSI O5.1 and treated according to AWPAC4 with oil-borne preservatives and petroleum complying with AWPAC8 and AWPAC9.
- C. Wood Species: Match Potomac Edison standard.
- D. Pole Marking Location: 10 feet (3 m) from the pole butt for poles 50 feet (15 m) long or less.
- E. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.

2.04 HARDWARE AND ACCESSORIES

- A. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, insulator pins, anchor rods, anchors, eyebolts, and staples.
1. Comply with ANSIC135.1, ANSIC135.2, ANSIC135.4, ANSIC135.14, ANSIC135.22, and RUS Informational Publication 202-1 listings with the exception that base material shall be malleable iron or ductile iron, and finish shall be hot-dip galvanized.
- B. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.
1. Anchors: Expanding, Plate, Swamp, or Power-installed screw type.
 2. Anchor Rods for Manual Installation: Threaded rod with integral thimble eye.
 3. Anchor Rods for Power-Installed Screw Anchors: ASTM A 53/A 53M, Schedule 80 pipe, with coupling, and thimble eye.
- C. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post- or -pin-type insulators, with two-bolt attachment to pole.
- D. Pole Riser Shields: Galvanized steel with boot. Coordinate with duct bank turn up.
- E. Insulators: Units rated 6 kV and above shall be free from radio interference.

1. Porcelain insulators shall be wet-process type, complying with the following types:
 - a. Pin: ANSI C29.5.
 - b. Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
 - c. Suspension: ANSI C29.2.
 2. Polymer-composite, fiberglass-reinforced insulators shall comply with the following:
 - a. Line Post: Comply with CEA LWIG-02.
 - b. Dead End/Suspension: Comply with CEA LWIG-01.
- F. Grounding Materials: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems," using materials listed by RUS for the intended purpose without restriction.
1. Conductors: No. 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B 8, unless otherwise indicated.
 2. Ground Conductor Protectors: PVC or half-round wood molding, fir, pressure treated according to AWPA C25.

2.05 SURGE ARRESTERS

- A. Available Manufacturers:
1. Cooper Power Systems.
 2. General Electric Company; Transmission Systems.
 3. Joslyn Manufacturing Company.
 4. Ohio Brass Company; Hubbell, Inc.
 5. Tyco Electronics/Raychem.
- B. Distribution-Class Surge Arresters: Porcelain-enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1. Voltage rating 10-kV

2.06 SOURCE QUALITY CONTROL

- A. Factory Inspections: Engage a qualified independent timber inspection agency to inspect poles before and after preservative treatment and report results of inspection.

PART 3 - EXECUTION

3.01 RIGHT-OF-WAY CLEARANCE AND TREE TRIMMING

- A. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of 15 feet (4.5 m) on both sides horizontally and below medium-voltage conductors. Remove overhanging branches (if applicable).

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install underground power circuits and those indicated to be in raceway according to Division 16 Section "Raceway" and Division 16 Section "Medium-Voltage Cable," and make splices and terminations for those circuits according to those Sections.
- B. Verify dimensions by field measurement, and identify locations of poles, guy anchors, and other features. Also identify locations of connection to new and existing supply lines and to primary services. Notify Engineer of discrepancies and field conditions that are not indicated and that will affect installation.
- C. Ground equipment according to Division 16 Section "Grounding."
- D. Apply warning signs and equipment labels according to IEEE C2.

3.03 CONDUCTOR INSTALLATION, GENERAL

- A. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.
 - 1. String new conductors to "initial" sag table values recommended by manufacturer for type and size of conductor.
- B. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials used in the connection, or recommended for the specific use by manufacturer of material on which applied.
 - 1. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
 - 2. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's written instructions.

3.04 MEDIUM-VOLTAGE LINE CONDUCTOR INSTALLATION

- A. Application: Install bare conductors, unless otherwise indicated.

- B. Armor Rod: Install to protect conductors if line conductors are supported by insulators.
- C. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.
- D. Support line conductors and taps as follows:
 - 1. Use wire ties for conductor attachment to pin and vertical post insulators, unless otherwise indicated.
 - 2. Install wire ties tight against conductor and insulator, and turn ends back, flat against conductor, to eliminate exposed wire ends.
 - 3. Use wire clamps on horizontal post, dead end, and suspension insulators, unless otherwise indicated.

3.05 POLE INSTALLATION

- A. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and according to the following:
 - 1. Match pole height of new pole to existing Potomac Edison Pole.
 - 2. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
- B. Set poles according to the following:
 - 1. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
 - 2. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
 - 3. Backfill holes in **6-inch (150-mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
 - 4. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
- C. Field treat factory-treated poles as follows:
 - 1. Poles Treated More Than One Year before Installation: Treat portion from **24 inches (600 mm)** above ground line to butt.
 - 2. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
 - 3. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
 - 4. Engage the services of a technician certified according to Part 1 of this Section to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field-applied treatment chemicals and application.

3.06 HARDWARE AND ACCESSORIES INSTALLATION

- A. Install washers against wood and under nuts, including eyenuts and locknuts.
- B. Install nuts and locknuts wrench-tight on threaded connections.

3.07 INSULATOR INSTALLATION

- A. Medium-Voltage Line Application: Install pin or post type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.
 - 1. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
 - 2. Install horizontal line-post insulators for armless construction.
- B. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.

3.08 SURGE ARRESTERS

- A. Install surge arresters to protect distribution, aerial-to-underground transitions, and other items indicated.

3.09 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. Furnish instruments and equipment required for tests that comply with NETA ATS.
 - 2. Ground Resistance: Comply with Division 16 Section "Grounding." Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.
 - a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
 - b. Results and Follow-up: If ground resistance for counterpoise tested, exceeds 25 ohms, add a ground electrode not less than 10 feet (3 m) away and interconnect with No. 4/0 AWG minimum bare conductor buried at least 12 inches (300 mm) below furnished grade.

3. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's Product Data and written recommendations.
 4. Self-Supported, Medium-Voltage Cable: After installation and while cable is isolated, after terminations are installed and before connecting or energizing, apply dc voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with applicable NEMA WC 70 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
 5. New Surge Arresters: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.
 - a. Verify proper grounding of metallic equipment parts.
 - b. Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

3.10 CLEANING

- A. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish.
 1. Clean enclosures internally, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 262100

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. All wiring shall be installed in raceways as hereinafter specified, unless otherwise indicated.

1.03 SUBMITTALS

- A. Submit product data for raceways, wireways and fittings.
- B. Submit manufacturer's written installation instructions for wireways and non-metallic raceways.
- C. **Submit pulling calculations for all underground ductbank runs having medium voltage cables, of all sizes or low voltage cables larger than 4/0.**

1.04 QUALITY ASSURANCE

- A. All raceway components and the installation of raceway components shall comply with the following standards:
 - 1. NFPA 70 "National Electrical Code"
 - 2. Applicable NEMA Standards
 - 3. Applicable UL Standards pertaining to raceway system
- B. Raceway components shall be listed and labeled by UL, ETL or CSA.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT

- A. Rigid metal conduits and couplings shall be full weight, heavy wall steel, galvanized, with threaded connections conforming to the latest editions and revisions of ANSI Standard C-80.1 and Federal Specifications WW-C-581E.
- B. Fittings shall be steel or cast malleable iron by Chrouse-Hinds, O-Z, T & B, Steel City, Efcor, or equal. O-Z type "AX" or equal fittings with bonding jumpers shall be used in each rigid metal conduit passing across a building expansion joint. Type of fitting shall be properly chosen for the movement anticipated.
- C. Insulating bushings shall be used on all rigid metal conduit terminations and shall be O-Z type "B" or equal.

- D. T & B Series 141, or equal, locknuts shall be used on both inside and outside on all enclosures.
- E. O-Z type "S", or equal, cable supports shall be used in conduit risers as required by the NEC.

2.02 INTERMEDIATE METAL CONDUIT

- A. Intermediate Metal Conduit (IMC) and couplings shall be steel, galvanized, with threaded connections, conforming to the latest editions and revisions of Federal Specifications WW-C-581E and Underwriter's Laboratories Standard 1242.

2.03 ELECTRICAL METALLIC TUBING

- A. Electrical Metallic Tubing (EMT) shall be galvanized, conforming to the latest editions and revisions of ANSI Standard C80.3, Federal Specifications WW-563, and Underwriter's Laboratories Standard 797.
- B. Expansion fitting with bonding jumpers shall be used in each EMT conduit passing across a building expansion joint.
- C. Steel concrete-tight (rain-tight in damp and liquid-tight in wet locations) compression type box connections and couplings with nylon insulating throats shall be used.
- D. O-Z type "SBT" or equal, insulated bushing shall be used on all EMT conduit terminations not in metal enclosures.

2.04 FLEXIBLE METAL CONDUIT

- A. Flexible metal conduit shall be steel, metal strip interlocked construction, zinc-coated, conforming to the latest editions and revisions of Federal Specification WW-C566B and Underwriter's Laboratories Standard for Flexible Steel Conduit, UL1.
- B. Liquidtight flexible metal conduit shall be type UL with PVC cover as manufactured by Anamet: trade name - "Sealtite," or "Hydrotite" as manufactured by Eastern Wire and Conduit or equal, conforming to UL360.
- C. Fittings and Connectors:
 - 1. Flexible Metallic Conduit: Steel, nylon insulated throat, equal to Crouse-Hinds ACB Series, or Thomas & Betts Tite-bite.
 - 2. Flexible Non-Metallic (Liquidtight): Steel, nylon insulated throat, equal to Crouse-Hinds Liquidator.
 - 3. Die-cast squeeze fittings will not be approved.

2.05 RIGID NONMETALLIC CONDUIT

- A. Polyvinyl Chloride (PVC) conduit shall be heavy wall Schedule 40 or Schedule 80 as noted conforming to the latest editions and revisions of Federal Specifications WC-1094, Underwriter's Laboratories Standard UL651, and NEMA Standard TC-2.
- B. All joints shall be leakproof, moisture-proof, permanent solvent cement type.
- C. Conduit and fittings shall be as manufactured by Carlon, Queen City Plastics or equal.

2.06 RIGID ALUMINUM CONDUIT

- A. Aluminum conduit shall not be used.

2.07 CONDUIT BODIES AND FITTINGS

- A. All couplings, elbows, cast fittings and conduit bodies shall be made of materials of high quality throughout and shall be a first-grade commercial product, well made and free from mechanical imperfections and defects.
- B. Bushings shall be used on all conduits to provide a smooth, well rounded, insulated surface. Bushings shall be metallic with plastic throats. The insulating material shall have a UL temperature rating of 302°F (150°C), it shall be molded-on to the metal and shall become an integral part of the bushing.
- C. Erickson or split couplings shall be used in lieu of running threads. Couplings shall be manufactured by O.Z./Gedney, or equal.
- D. Entrance seals shall be provided where conduits pass through exterior concrete or masonry walls below grade. The entrance seals shall consist of a hot dip galvanized shell, sealing gland assembly capable of providing a seal around the conduit to withstand fifty feet head of water without leakage. The shell of the seal shall have at least two (2) cast collars at a right angle to the sleeve that is embedded in the concrete. Entrance seals shall be O.Z./Gedney Type WSK, FSK or equal.
- E. Conduit hubs shall be malleable iron, zinc plated rain-tight type complete with integral insulated throat, captive O-ring seal and oversize nut. Hubs shall be Myers "Screwтите," O.Z./Gedney "Space Maker," or equal.

2.08 WIREWAYS

- A. Electrical wireways shall be of the type, size and number of channels as indicated.
- B. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match in form, fit and finish the wireway as required for a complete installation.

2.09 IDENTIFICATION

- A. Exposed raceways shall be identified at junction and pull boxes and at points not more than 20 feet (6 m) on centers. See Division-16 Section, Basic Materials and Methods for additional identification requirements.
- B. Labels shall indicate the system voltage and/or type of service and shall have an appropriate legend, such as:
 - 1. 240/120 VOLTS - LIGHTING
 - 2. 240/120 VOLTS - POWER
 - 3. 120 VOLTS - CONTROL
 - 4. FIRE ALARM
- C. Labels shall appear in white letters of 1/2 inch (13 mm) minimum height on a black background. Labels shall be installed in accordance with the manufacturer's instructions and sizes shall match the conduits to which they are applied. Labels shall be ordered sufficiently prior to their need so that they will be on hand when required for installation. Failure to allow adequate time for delivery of labels, including special legends, will not be considered valid reason for substitution of labels of a different type.

PART 3 - EXECUTION

3.01 WIRING METHODS

- A. Exterior locations above grade - rigid metal conduit.
- B. Crawl spaces - intermediate metal conduit.
- C. Exposed locations, up to 10' - 0" (3 m - 0 mm) AFF – rigid metal conduit.
- D. Exposed locations, above 10' - 0" (3 m - 0 mm) AFF - electrical metallic tubing.
- E. Damp or wet locations - rigid metal conduit.
- F. Within concrete and masonry exterior walls - intermediate metal conduit.
- G. Below slabs on grade - rigid nonmetallic Schedule 40 PVC with rigid metal conduit stub-ups.
- H. Conduits for all conductors rated greater than 600V – Schedule 40 PVC encased in minimum 3" of concrete. Provide rigid metal stub-ups.
- I. Concealed locations, accessible, dry - electrical metallic tubing.
- J. Concealed locations, non-accessible, dry - electrical metallic tubing.
- K. Direct buried, exterior, branch circuits (60 amperes or less) - rigid nonmetallic Schedule 80 PVC.

- L. All feeders below 600V: Ducts encased in minimum of 3 inch (75 mm) thick concrete - rigid nonmetallic Schedule 40 PVC. All ducts shall have a round exterior with a round bore. Provide rigid metal stub-ups.
- M. Connections to motor terminal boxes, control panels mounted on equipment, motors and other vibration producing equipment, dry locations - flexible metal conduit, 18"-36" (450 mm-900 mm) length.
- N. Connections to motor terminal boxes, control panels mounted on equipment, motors and other vibration producing equipment, damp and wet locations - liquidtight flexible metal conduit.
- O. Lighting fixtures, between fixture and its respective outlet box - flexible metal conduit in lengths as permitted by the NEC, and providing sufficient slack to permit removal of fixture and access to outlet box.
- P. Minimum conduit size shall be 3/4" (19 mm).
- Q. Non-insulating grounding conductors installed within a raceway shall be PVC Schedule 40 (where allowed by Code) or non-ferrous conduit.

3.02 INSTALLATION

- A. Unless otherwise noted on the contract drawings, all raceways shall be installed concealed in the floors, ceilings, walls or partitions of the building, and in such a manner as not to impair the integrity of the structure. Unless otherwise specified, raceways may be installed exposed in mechanical rooms, electrical rooms, large storage spaces and in large janitor's closets, pipe shafts, suspended ceiling spaces, and where required for equipment connections. Exposed raceways shall be installed parallel or perpendicular to walls, structural members or intersection of vertical planes and ceilings, with right angle turns consisting of box-type fittings or symmetrical bends.
- B. The Contractor shall exercise the necessary precautions to prevent water, dirt, plaster, or trash in raceways, fittings and boxes during the course of installation; raceways, fittings, or boxes clogged in such manner that cannot be thoroughly cleaned, shall be replaced. All unconnected conduit ends shall be properly capped. Raceways shall be kept at least 12 inches (300 mm) from parallel runs of flues, steam pipes or hot water pipes. Bends and offsets shall be kept to a minimum, and they shall be made without flattening or deformation with approved hickey or bending machine; the radius of the curve of the inner edge of any field bend shall not be less than the value specified in the National Electrical Code. Raceway runs shall not exceed 100 feet (30 m) between outlets; where necessary, even though not indicated on the drawings, box-type fittings or pull boxes shall be installed. Moisture traps shall be avoided as much as possible. Raceways shall not be installed horizontally within concrete slabs-on-grade; raceways shall be installed underground, below the slab. Expansion fittings or other approved devices shall be used to provide for expansion and contraction where raceways cross expansion joints.

- C. Raceways shall have supports spaced not more than 8 feet (2400 mm) apart, except in vertical risers where 2 inch (50 mm) and larger rigid metal conduit may be supported at intervals not larger than 15 feet (4.5 m). Raceways shall be supported on approved types of zinc-coated wall brackets, clamps, ceiling trapeze hangers, strap hangers, or pipe straps firmly secured in an approved manner. All ends of raceways shall be reamed to remove rough edges. Raceways shall be firmly attached to sheet-metal enclosures NEMA type 1 by means of proper metallic, plastic throated bushings and locknuts; and to sheet-metal enclosures NEMA types 3, 4, 6, 12 or 13, by means of interchangeable, metallic, plastic-throated, raintight hubs. When installing locknuts and bushings, care shall be observed to see that the full number of threads project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be made up sufficiently rigid to draw the bushing into firm electrical and mechanical contact with the box; two locknuts, one inside and one outside, plus the bushing, shall be used where required. Proper electrical continuity shall be established throughout the entire raceway system. An approved compound shall be applied to all field threads before installation.
- D. All conduits shall be tested for clearance and smooth joints and then capped immediately after installation by T & B "push penny" plugs, or equal, to prevent entrance of moisture or debris.
- E. No wire shall be pulled into conduits until system is complete and the building is thoroughly dry.
- F. Conduits to outlets in demountable or dry wall partitions shall be run in ceiling spaces and not in floor slabs.
- G. Conduits turning from floor slabs up into partitions shall be totally concealed.
- H. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc., shall be suitably sealed with "Duxseal" by Johns Manville or sealing fittings to prevent accumulation of condensation.
- I. Conduits and sleeves penetrating floor slabs and fire-rated partitions shall have the chopped out space between the outer wall of the piping and the concrete sealed with fire resistant material listed by UL for use in fire rated floor and partition systems. Sleeves penetrating floor slabs shall extend 1-1/2" (40 mm) above the finished floor.
- J. Conduits less than 12" (300 mm) in length connecting outlets of adjoining rooms shall be sealed with "Duxseal" by Johns Manville to prevent noise transmission between rooms.
- K. Pull wires shall be installed in all empty conduits. Use No. 14 AWG monofilament plastic line having not less than 200-lb. (1380 kPa) tensile strength. A minimum of 12 inches (300 mm) of slack shall be provided at each end of the pull wire.

3.03 UNDERGROUND DUCTS

- A. Underground electrical and communication ducts shall be located a minimum of 6 feet (1800 mm) away from steam and hot water lines except at crossings where a 1 foot (300 mm) separation shall be permitted.
- B. Unless otherwise noted or specified, underground raceways shall be installed 36 inches, minimum, below grade for 600 volts and 36 inches, minimum, below grade for higher voltages. The bottom of the trench shall be even and firm and shall be free of rocks and sharp objects; the trench shall be backfilled with clean, rock-free soil, in 6-inch (150 mm) layers and each layer shall be compacted before addition of subsequent layers. The surface (turf, sidewalk, roadway, etc.) shall be restored to its original condition.
- C. Ducts shall be installed below the frost line at the project site location.
- D. Ducts for electrical power circuits shall be completely isolated from ducts for communication circuits. Separate access points and termination points shall be provided. Ducts for electrical power circuits and ducts for communication circuits may share the same trench when such an arrangement is approved by the appropriate utility and owner.
- E. A minimum 3 inch (75 mm) clearance shall be maintained between raceways in multiple raceway installations. Rigid PVC spacers shall securely support and maintain uniform spacing of the duct assembly. A minimum of 3 inches (75 mm) shall be maintained between the duct assembly and the bottom of the trench during backfilling. Spacers shall be installed at intervals not exceeding 4 feet (1200 mm). Provide non-ferrous tie wires to prevent displacement of the ducts. Tie wires shall not act as substitutes for spacers.
- F. Ducts shall be sloped away from building and equipment entrances. Pitch shall be not less than 4 inches (100 mm) in 100 feet (30 m). Curve sections in duct lines shall consist of long sweep bends. The use of manufactured bends shall be limited to building entrances and stub-ups to equipment.
- G. Only standard 3,500 psi ready-mix concrete with air entrainment and pea gravel will be approved for encasement.
- H. Underground conduit stub-ups to equipment inside of buildings shall be galvanized rigid steel. Stub-ups to equipment mounted on outdoor concrete slabs shall be galvanized rigid steel. Install insulated grounding bushings on the terminations. The steel stub-ups shall be coupled to the ducts with suitable adapters.
- I. Ducts shall be kept clean of earth, sand or gravel during construction, and sealed with tapered plugs upon completion of each portion of the work. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of soft earth, sand, or foreign material left in the duct line. The mandrel shall be not less than 12 inches (300 mm) long, and shall have a diameter 1/2 inch (13 mm) less than the inside

diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be slightly larger than the diameter of the duct.

- J. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- K. Duct lines shall terminate at window openings in hand hole walls as shown on the Drawings. All ducts shall be fitted with end bells.
- L. Couple the ducts with proper couplings. Couplings shall be staggered in rows and layers to insure maximum strength and rigidity of the duct bank.
- M. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts, conduits, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes, where applicable, to insure smooth durable transitions.
- N. Underground cables, raceways and ducts shall have a continuous strip of heavy gage plastic approximately 6 inches (150 mm) wide installed 12 inches (300 mm) below the surface over ducts or conduits before backfilling trenches. Plastic strip shall be printed with the words "Caution - Buried Electrical Line Below," or a similar phrase approved by the Engineer.

3.04 EXCAVATION AND BACKFILLING

- A. The Contractor shall provide necessary excavation and backfill for the installation of electrical work. The Contractor shall coordinate work with other trades to avoid interference and minimize trenching. Establish all lines and grades required for the proper location of the work and be responsible for the correctness thereof. Verify location and check elevations of all existing utilities before starting work.
- B. Provide guard rails and other necessary safeguards around excavation. Provide shoring, bracing, etc. to protect work, safety of personnel, and existing utilities and underground work. Provide protection against injury of adjacent property. Keep excavation drained and pumped out. Do not permit debris and other materials to enter drains and piping.
- C. Excavate to depth and width required for proper installation of electrical work with minimum clearance of 8 inches (200 mm) on each side and minimum overdepth of 6 inches (150 mm). Excavated materials not required or suitable for backfill shall be removed from the site. Where excess excavation is made, backfill to required level with concrete or crusher run (CR6).
- D. Deposit initial layer of backfill, six inches (150 mm) deep, over conduit, duct, ductbank or cable and tamp. Deposit individual layers of backfill in 6 inch (150 mm) layers and tamp. Backfill material under roadway, structures, and equipment, etc. shall be compacted sand. Backfill material shall be free of

organic matter, cinders, frozen earth or rock larger than 4 inches (100 mm) in any dimension.

- E. Repair and/or replace any curbs, roads, walks fences, utilities or structures disturbed as a result of the work. Seed or sod all areas disturbed as a result of the work.
- F. Refer to Civil Documents for additional information.

3.05 CLEANING

- A. Inspect all raceways; clear all blockages; and remove all burrs, dirt and construction debris from raceways before installing conductors.

END OF SECTION 16130

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this section.

1.02 SUMMARY

- A. The Contractor shall furnish and install all handholes, and all accessories and materials required for a complete underground distribution system as indicated on the Drawings.
- B. The Contractor shall coordinate all work with the appropriate utilities and the Owner. No work shall be performed until a written schedule is provided to the Owner, and written approval of the schedule is received from the Owner.

1.03 SUBMITTALS

- A. Provide manufacturer's product data for all fittings, handholes, and all manufactured accessories.
- B. Provide Shop drawings for all handholes, and all field-fabricated supports, brackets and accessories.
- C. Provide site plans and profiles of handholes, and ducts.

1.04 QUALITY ASSURANCE

- A. All underground handholes and the installation of underground handholes and components shall comply with the following standards:
 - 1. NFPA 70, "National Electrical Code"
 - 2. National Electrical Contractors Association's "Standard of Installation"
 - 3. Applicable IEEE/ANSI Standards

PART 2 - PRODUCTS

2.01 POLYMER CONCRETE UNDERGROUND ENCLOSURES

- A. Enclosures shall be polymer concrete. The enclosures shall be suitable for direct buried applications in soil, concrete embedment, or asphalt embedment.
- B. The enclosures shall be concrete/cement gray in color, unless otherwise specified.
- C. The enclosure dimensions shall be as indicated on the Drawings. The enclosure shall have an open bottom. Knockouts shall be notched to allow for a smooth edge upon removal.
- D. The cover shall have a logo that reads "ELECTRIC". The cover shall have two

lifting eyes/pull slots with the following dimensions – 1/2” x 4” with a 1/4” center pin. The cover’s surface shall be skid resistant and have a minimum coefficient of friction of 0.50, as specified in current ANSI/SCTE 77. The cover shall have two locking bolt slots, and two 3/8” – 16 UNC hex head bolts to secure the cover into the box.

- E. The enclosures (box and cover) shall comply with all of the environmental tests as per current ANSI/SCTE 77.
- F. The enclosures (box and cover) shall be current ANSI/SCTE 77 Tier 22 and shall be UL Listed to 66WF and tested to the full ANSI standard.
- G. Basis of Design is Hubbell enclosures Quazite. Approved equals shall be accepted of conforming to this specification.

PART 3 - EXECUTION

3.01 POLYMER CONCRETE HANDHOLES

- A. Handholes, shall be installed by or under the supervision of the manufacturer, in accordance with the manufacturer's written instructions.
- B. Concrete aprons shall be used to bring the cover of handholes to the finished grade.
- C. Handholes shall be located in accordance with the Drawings, and shall be set in place on a gravel bed to ensure a plumb installation.
- D. Provide excavation and backfilling. Refer to detail on drawings. Internal Bracing may be warranted for any manufacturer’s underground enclosure if 95% compaction is required or if heavy vehicles are going to be present during construction and/or throughout the life of the enclosure. See manufacturer recommended practices and instruction including applicable sizes that would require internal bracing.

END OF SECTION 16132

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this Section.

1.02 SUMMARY

- A. Provide and install outlet boxes, pull and junction boxes, cabinets and enclosures as required by the Drawings and as required by field conditions for a complete installation in accordance with the National Electrical Code.

1.03 SUBMITTALS

- A. Provide product data for all cabinets and enclosures.

1.04 QUALITY ASSURANCE

- A. All items provided under this Section shall be listed and labeled by UL or a Nationally Recognized Testing Laboratory (NRTL).
- B. The components and installation shall comply with NFPA 70 "National Electrical Code."
- C. Enclosures shall comply with NEMA Standard 250, "Enclosures for Electrical Equipment."

PART 2 - PRODUCTS

2.01 METALLIC OUTLET BOXES

- A. Outlet boxes shall conform to UL 514A, "Metallic Outlet Boxes, Electrical," and fittings shall conform to UL 514B, "Fittings for Conduit and Outlet Boxes."
- B. Outlet boxes for indoor and dry locations shall be minimum 4" (100 mm) square or octagonal, 2-1/8 inch (53 mm) deep, zinc-coated sheet steel with stamped knockouts, threaded screw holes and mounting accessories suitable for each location and application. Straps, cable clamps, exterior rings and fixture studs shall be provided as required.
- C. Outlet boxes for outdoor or wet locations shall be minimum 4" (100 mm) square copper-free aluminum cast boxes with threaded raceway entries, threaded screw holes and mounting accessories suitable for each location and application. Straps, mounting feet, closure plugs, cable clamps, exterior rings and fixture studs shall be provided as required.
- D. Outlet boxes in concrete construction shall be of sufficient depth to keep conduits a minimum of 1" (25 mm) from the wall surface.

- E. No "thru-wall" boxes shall be used in partitions.
- F. Steel floor boxes shall be sheet steel construction, concrete tight, fully adjustable, with stamped knockouts, adjusting rings, and brass floor plates.
- G. Outlet boxes in masonry partitions shall have square corners with no mounting tabs and shall be of sufficient depth to suit the block or brick construction.

2.02 NONMETALLIC OUTLET BOXES

- A. Nonmetallic outlet boxes shall not be used.

2.03 PULL AND JUNCTION BOXES

- A. Pull and junction boxes over 100 cubic inches (.0016 m³) in volume shall comply with UL Standard 50, "Electrical Cabinets and Boxes."
- B. Boxes shall have screwed or bolted-on covers of the same material as the box and shall be sized to accommodate the application and the site conditions.
- C. Sheet steel boxes shall have welded seams and shall have structural bracing where required to provide a rigid assembly.
- D. All boxes for concealed work shall be constructed of minimum 12 gauge galvanized sheet steel with welded seams and shall be provided with mounting brackets. Integral bracing shall be provided where required to provide a rigid assembly.
- E. All boxes installed in wet locations or on the building exterior shall be constructed from galvanized sheet steel with gasketed covers.
- F. All exterior boxes shall be lockable.

2.04 CABINETS

- A. Cabinets shall conform to UL Standard 50, "Electrical Cabinets and Boxes."
- B. Backboxes shall be constructed from galvanized sheet steel, and fronts and doors shall be constructed from rolled sheet steel. Cabinets shall be NEMA 1 except as otherwise noted. Cabinets shall consist of a box and a one-piece frame front with a hinged door. Concealed fasteners shall secure front to box and provide adjustment to permit alignment of front and box.
- C. Hinges shall be flush, shall not be more than 6" (150 mm) from the top and bottom of the door, and shall be no more than 24" (600 mm) apart. Doors greater than 48" (1200 mm) in height shall have 3-point latching mechanism.
- D. Surface mounted cabinets shall have fronts of the same height and width as the box. Flush mounted cabinets shall have fronts which extend 3/4" (19 mm) beyond box in all directions.

- E. Double doors shall be provided for cabinets wider than 24" (600 mm).
- F. Doors shall have combination spring catch and key lock. All locks for cabinets of a common system shall be keyed alike.

PART 3 - EXECUTION

3.01 OUTLET BOXES

- A. Outlet boxes shall be firmly secured in place, plumb and level. Outlet boxes installed in suspended ceilings shall not be supported from the ceiling system. Outlet boxes for like devices shall have a uniform mounting height unless specifically noted otherwise.
- B. Outlet boxes over windows and doors shall be installed 7'-6" (2250 mm) above the finished floor, centered over the door or window unless otherwise noted.
- C. Outlet boxes shall be 6"-12" (150 mm-300 mm) from the strike side of the door frame when installed adjacent to a door opening.
- D. Covers shall be installed on all outlet boxes.
- E. Outlet box mounting heights are as indicated. Mounting heights shall be to the center line of the box.

3.02 PULL AND JUNCTION BOXES

- A. Pull and junction boxes shall be no smaller than 8 inches (200 mm) square by 4 inches (100 mm) deep.
- B. Boxes shall be the minimum size as required by the National Electrical Code or larger as indicated on the Drawings.
- C. Junction and pull boxes shall be furnished and installed where indicated on the Drawings or where required by the NEC. On the exterior, mount at 72" AFG UON.

3.03 CABINETS AND ENCLOSURES

- A. Fronts of cabinets and enclosures shall be mounted straight and plumb with building surfaces.
- B. Cabinets and enclosures 68" (1700 mm) or less in height shall be installed with the top of the cabinet or enclosure 72" (1800 mm) above the finished floor. All cabinets and enclosures shall be installed in accordance with the NEC.
- C. Cabinets and enclosures installed adjacent to one another shall be installed with the tops of the cabinets and enclosures at the same height.

- D. Cabinets and enclosures in finished areas shall be flush with the walls. Cabinets and enclosures in mechanical and electrical rooms shall be surface mounted unless otherwise noted.

3.04 GROUNDING

- A. All metallic boxes, cabinets and enclosures shall be effectively grounded in accordance with Article 250 of the NEC.
- B. Provide a grounding terminal in the interior of all boxes, cabinets and enclosures.

3.05 CLEANING

- A. After installation, clean and repair all boxes, cabinets and enclosures. Galvanized finishes shall be repaired using a zinc-rich paint as recommended by the manufacturer. Painted finishes shall be repaired using a matching paint from the manufacturer.

END OF SECTION 16135

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.
- B. The requirements for outlet boxes and device enclosures are provided in Division-16 Section, Boxes, Fittings and Cabinets.

1.02 SUMMARY

- A. The Contractor shall furnish and install all wiring devices indicated on the Drawings or specified herein.

1.03 SUBMITTALS

- A. Provide product data for each type of wiring device specified.

1.04 QUALITY ASSURANCE

- A. All products and the installation of all products shall comply with NFPA 70, "National Electrical Code."
- B. Wiring devices shall be listed and labeled by UL and shall confirm to the latest UL and NEMA standards pertaining to wiring devices.

PART 2 - PRODUCTS

2.01 WIRING DEVICES

- A. All wiring devices shall be Specification Grade.
- B. Wiring devices shall be white in color unless otherwise indicated.
- C. Convenience receptacles shall be duplex, grounding type, 20A, 2P, 3W, 125V, NEMA 5-20R, straight blade, nylon or high-strength thermoplastic material.
- D. Convenience receptacles serving commercial kitchens (15 and 20 ampere branch circuits), bathrooms, toilets, garages, outdoor and wet locations, and construction sites shall be of the ground fault interrupter type, duplex, grounding type, 20A, 2P, 3W, 125V, NEMA 5-20R, straight blade, nylon or high-strength thermoplastic material.
- E. Convenience receptacles located in wet locations shall be of the ground fault interrupter, weather resistant type, duplex, grounding type, 20A, 2P, 3W, 125V, NEMA 5-20R, straight blade, nylon or high-strength thermoplastic, corrosion resistant material.
- F. Single throw toggle switches shall be quiet type rated 20A, 1P, 120/277 VAC.

- G. Three-way toggle switches shall be quiet type rated 20A, 120/277 VAC. Switches shall be positive-action type and shall not permit a maintained neutral position.
- H. Wall plates for switches, receptacles, etc. in indoor dry areas, shall be satin finish stainless steel Type 302 for concealed raceways; and zinc-coated sheet steel or cast metal having round or beveled edges, for exposed raceways. Install galvanized steel wallplates in unfinished spaces.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting and installation of electrical boxes and wiring.
- C. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- D. Install wiring devices after wiring work is completed.
- E. Install wallplates after painting work is completed.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- G. Protect installed components from damage. Replace damaged items prior to final acceptance.
- H. Provide weatherproof, while-in-use covers for all receptacles located in wet locations.

3.02 TESTING

- A. Prior to energizing circuits, test wiring for electrical continuity and short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device at least six (6) times.
- B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

END OF SECTION 16140

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this Section.

1.02 SUMMARY

- A. The Contractor shall provide electrical connections to and between all equipment indicated on the Drawings and Schedules and in the Specifications.
- B. Electrical connections shall be provided for, but not limited to, electrical heaters, lighting fixtures, motors, motor starters and controllers, electrical distribution equipment, and transformers.
- C. Unless otherwise specified, the Contractor shall, under this Section, mount and align all starters, control devices, safety switches and other related equipment whether specified in this or other Sections of the specifications, except where such items are factory mounted on the driven equipment. The mounting and alignment of starters and control devices for the automatic temperature control system are included in the Sections in which the equipment is specified.
- D. Unless otherwise specified, the Contractor shall, under this Section of the specifications, provide all wiring, including conduit, wire, junction boxes, disconnecting switches, overcurrent protection, etc., not specified elsewhere in this specification, to and between all motors, starters, control devices and related electrical equipment, whether specified in this or other Sections of this specification, except where such items are factory wired, as well as factory mounted on the driven equipment.
- E. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment, shall be installed in conduits with flexible metal conduit connections utilized for final motor connections. Flexible conduits shall be large enough to accommodate motor feeder, ground conductors, and control wires, whether or not so indicated on the drawings. Flexible conduits shall be limited to a maximum length of 6'-0" (1800 mm - 0 mm).
- F. The drawings are diagrammatic. It is imperative that the contractor obtain exact rough-in information for all equipment well in advance of actual installation to provide coordination for his and other trades.

1.03 SUBMITTALS

- A. Submit product data for all materials and components used for electrical connections.

1.04 QUALITY ASSURANCE

- A. All materials and components and the installation of all materials and components shall comply with the requirements of the following standards:
 - 1. NFPA 70 "National Electrical Code"
 - 2. IEEE Standard 241 "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings"
 - 3. Applicable standards of ANSI/IEEE and NEMA pertaining to the products and installation of products for electrical connections
 - 4. UL Standard 486A "Wire Connectors and Soldering Lugs for Use with Copper Conductors"
- B. All materials and components shall be listed and labeled by UL or ETL.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide all materials and components required for complete splices and terminations of all circuits. All wiring shall be spliced and terminated using lugs and/or terminal blocks, except as permitted elsewhere in these Specifications.
- B. All splices in branch circuit wiring rated 600 volts and less, except as permitted elsewhere in these Specifications, shall be made using compression type lugs specifically designed for the type, size and rating of the conductor. The lugs shall be installed using a tool specifically designed for the purpose.
- C. Splices in copper branch circuit wiring for sizes #12 and #10 AWG may be made with non-tool, pre-insulated, molded wire connectors with integral self-locking spring grip.
- D. All terminations of feeders and branch circuit wiring rated 600 volts or less, except as noted elsewhere in these specifications, shall be made using mechanical clamp-type set-screw lugs. Lugs which incorporate direct contact between the set-screw and the conductor shall not be permitted.
- E. Tapes:
 - 1. Self-adhesive tapes shall be used to insulate conductor splices. Terminations shall be in conformance with the following standards:
 - a. 600 Volts, Nominal and Less: UL 510, ASTM D-2754, ASTM D-3005, and ASTM D-4388.
 - b. 600 Volts through 69 Kilo Volts: ASTM D-4388 and IEEE 48.
 - 2. Vinyl plastic electrical tape shall be used for all terminations and splices of conductors for circuits of 600 volts nominal and less, except terminations in motor terminal boxes, transformer terminations, lighting and all heat producing equipment terminations. Terminations of the

- equipment listed herein shall be insulated with pressure sensitive glass cloth tape.
3. Ethylene propylene rubber (EPR) high voltage insulating tapes with liner shall be used for all splices and terminations over 600 volts nominal. The tapes shall be included a standard component of the manufacturer's compiled high voltage splice termination kits. All splices and terminations of 15 kV cables shall be accomplished with high voltage splice and termination kits only.
 4. Tapes and high voltage splice and termination kits shall be the standard product of 3M Corporation, Plymouth Rubber Company, Inc. or approved equivalent.
- F. Special lugs may be required to accommodate the size and number of conductors shown on the Drawings. The Contractor shall verify lug requirements for all circuit breakers and equipment terminals and shall provide correct lugs as required.
- G. Pre-insulated solderless ring or spade type crimp connectors and terminals shall be used for all alarm and control circuits.
- H. All connectors and terminals shall be of the proper size and ampacity, material and type for the application and service.

2.02 RACEWAYS AND FITTINGS

- A. The Contractor shall provide raceways and fittings of the types, sizes, and finish indicated for each type of service. Where the type of raceway is not specified, the Contractor shall provide and install a raceway of proper selection as determined by the installer to fulfill the wiring and equipment connection requirements and comply with NEC requirements for raceways.
- B. All raceways and fittings and the installation of all raceways and fittings shall comply with the requirements of these Specifications.

PART 3 - EXECUTION

3.01 INSPECTION

- A. The Contractor shall inspect the area where electrical connections are to be installed. The installation of electrical connections shall not be permitted until site conditions are satisfactory.

3.02 INSTALLATION

- A. The Contractor shall install all electrical connections in accordance with the manufacturer's written instructions using recognized industry practices.
- B. Power, control, and signal circuits shall be connected to equipment in accordance with the manufacturer's wiring diagrams. The Contractor shall be fully responsible for the correct termination and interface of all electrical connections.

- C. Splices shall be insulated with tape which provides an insulation rating which meets or exceeds the insulation rating of the conductor. All outdoor splices shall be made watertight using tapes and sealants specifically designed and listed for outdoor applications.
- D. Wiring devices shall not be used as splices.
- E. Electrical connections shall be tightened in accordance with equipment manufacturer's published torque tightening values. The installer shall use proper tools which shall include torque screwdriver, torque wrench, and ratchet wrench with adjustable torque settings.
- F. UL Standard 486A torque tightening values shall be used when manufacturer's published tightening values are not available.

3.03 TESTING

- A. All electrical connections shall be tested to ensure electrical continuity and compliance with these Specifications.
- B. The Contractor shall demonstrate to the Owner or Engineer that a random selection of electrical connections has been tightened in accordance with the manufacturer's published torque tightening values.

END OF SECTION 16150

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. The Contractor shall furnish and install a factory assembled diesel-engine-driven generator set including fan, radiator, rigid mounting base, vibration isolators, silencer, overcurrent protection, sub-base fuel tank, controls and all accessories specified herein and as required for a complete and functional system.
- B. The diesel-engine-driven generator system shall comply with the requirements of NFPA 110, Type 10, Level 1, Class 6 emergency power supply systems.

1.03 SUBMITTALS

- A. Submit manufacturer's data sheets, wiring schematics installation dimensional drawings for Owner/Engineer, review, comments, and/or approval.
- B. Identify all specified items on submittals to assure compliance and ease of review and/or approval.
- C. Prior to final test and acceptance, submit final data sheets, schematics and dimensional drawings in neat brochure form.
- D. **Contractor shall provide available maintenance contract information and pricing along with their bid.**
- E. Provide special warranty for 5 years / 3000 hours.
- F. Include manufacturer's 6 month, 12 month, and 24 month preventative maintenance in the base bid.
- G. Submittal Data Required:
 - 1. Complete installation drawings, including plan view and elevation with connection of required utilities clearly indicated.
 - 2. Engine/generator controls.
 - 3. Actual electrical schematic, interconnection, and control diagrams.
 - 4. Exhaust silencer and vibration isolators.
 - 5. Battery, battery rack, and battery charger data and installation details.
 - 6. Engineering performance data sheets describing engine, engine performance, fuel consumption rates at 1/4, 1/2, 3/4 and full load, ventilation and combustion air CFM generator details and performance data.
 - 7. The manufacturer shall submit a copy of the specifications with each sub-paragraph noted with the term, "compliance", "deviation", or

"alternate".

- a. By noting the term "compliance" it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
- b. By noting the term "deviation" it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
- c. By noting the term "alternate" it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.

1.04 QUALITY ASSURANCE

- A. All components of and the complete installation of the diesel generator system shall comply with all applicable requirements of the National Electrical Code relating to emergency and standby power systems.
- B. The diesel generator system shall conform to the applicable requirements of the following standards and authorities:
 1. NFPA - 37 "Installation and Use of Stationary Combustion Engines and Gas Turbines"
 2. NFPA 110 "Emergency and Standby Power Systems"
 3. ANSI/NEMA Standards MG-1 and MG-2
 4. Diesel Engine Manufacturer's Association (DEMA)
 5. Electrical Generating Systems Marketing Association (EGSMA)
 6. Environmental Protection Agency (EPA)
 7. UL 2200.
 8. UL 142.
 9. NFPA 30

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. MTU Onsite Energy (Basis of Design).
 2. Kohler
 3. Caterpillar
 4. Onan/Cummins

2.02 ENGINE

- A. Diesel fueled, compression ignition firing type cylinder arrangement, 1800 RPM, water cooled with unit mounted radiator, jacket water heaters, mounting frames, and spring-type vibration isolators.

- B. The engine shall be specifically designed to operate using #2 diesel fuel. Maximum fuel consumption shall be 15 gallons per hour at full load, and 7 gallons per hour at 50% load.
- C. Engine shall be fully equipped with fuel, lube oil and air intake filters; lube oil coolers; fuel transfer pumps; fuel priming pump; flexible fuel lines; service meter; gear driven water pump; unit mounted instruments including a water temperature gauge, and lube oil pressure gauge; service indicators for air cleaner and fuel filter.
- D. Provide and install a skid mounted, sub-base located diesel fuel storage tank of steel construction with a capacity of 400 usable gallons. This fuel tank shall support the full weight of the unit. The tank shall be internally coated with corrosion inhibitor, and externally painted to match overall unit color. The fuel tank shall be equipped with a visual fuel gauge, 2 inch (50 mm) fill connection, full flow breather vent, and tank drain located at the opposite end to the fill connection. All piping connections to the equipment shall be made with flexible connectors. Provide a level switch for low level alarm circuitry.
 - 1. Tank shall be double wall with leak detection and alarm.
 - 2. Provide 5 gallon spill/fill containment box.
 - 3. Tank shall be approximately 36" tall and have a footprint of 41" W x 112" L. Ensure that the tank and generator will fit in the space with all required clearances (for airflow per supplier and per code). Provide minimum 5' clear on all sides. The generator shall have approximately 5' clear from the structure above. Provide equipment that fits these requirements. If required, provide steps integral to the tank on each side for access to electrical components.
- E. Engine exhaust silencer shall be critical zone type, side inlet, inline outlet, flanged inlet and outlet connections to match engine exhaust outlet flanges, and flexible stainless exhaust connection section between engine and silencer.
- F. Governor shall be electronic type, isochronous with manual and automatic speed control. Governor shall be capable of +/- 0.25% steady state frequency regulation. Speed shall be sensed by magnetic pickup off the engine flywheel.
- G. Unit-mounted radiator, blower fan, engine-driven water pump, thermostat and radiator duct flange shall be provided. The cooling system shall cool the engine in a 125°F (52°C) ambient with up to 0.5 inches (13 mm) of water static pressure on the fan.
- H. Shut-off devices and circuitry for high water temperature, low oil pressure, engine overspeed, engine overcrank, and high oil temperature shall be provided.
- I. Jacket water heaters rated at 120V or 240V, 1-phase, and automatic thermostats shall be provided.
- J. Provide summary alarm contacts (1 N.O. and 1 N.C. rated 10 amperes, 120

VAC) to operate on any one or combination of the following alarms: low oil pressure, high water temperature, overcrank, engine-generator control switch not in automatic and low DC voltage.

2.03 STARTING SYSTEM

- A. Starting system shall be 24 volts DC, with positive engagement starting motor mounted on the engine.
- B. The starting system shall include fully automatic and manual start-stop features. The system shall include overcrank lockout and shut down after five (5) ten-second cranking periods.
- C. Provide 24 VDC lead-acid battery, heavy-duty diesel engine starting type. Battery shall be rated not less than 220 AH and shall provide 120 seconds of cranking power for the engine at the lowest ambient temperature to be encountered. Provide epoxy-treated steel battery rack, intercell and intertier connectors, lugs and cables.
- D. Battery charger shall be mounted, in a NEMA 1 enclosure, with float and equalizing charge rates to match battery manufacturer's requirements to maintain proper charge condition, current limiting with overload protective devices, silicon diode full wave rectification, voltage surge suppressor; DC ammeter and voltmeter (+/- 5 percent), fuse protected 120 volt single phase AC input, minimum 10 amp output. Provide low DC voltage alarm relay with one N.O. and one N.C. alarm contact.

2.04 GENERATOR

- A. The generator shall be rated 200 KW, 200 KVA at 1.0 power factor, 240/120 volts, 60 HZ at 1800 RPM.
- B. The generator shall be a single-phase, single bearing, 54°F (130°C) rise, synchronous type built to NEMA standards. Class F insulation shall be used on the stator and rotor, and no materials which will support fungus growth shall be used. The generator shall include a resettable protector for exciter/regulator protection against extended low power factor loads, and two-level heat detectors.
- C. A generator-mounted, exciter/regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be plus or minus 1% from no load to full rated load. Readily accessible voltage drop, voltage level, and voltage gain controls shall be mounted on the regulator. Voltage level adjustment shall be a minimum of plus or minus 10%. The solid-state regulator module shall be shock-mounted and epoxy-encapsulated for protection against vibration and atmospheric deterioration.
 - 1. Transient Response: The generator shall endure up to 312 Starting KVA with no more than a 35% voltage dip and 10% frequency dip.
- D. Generator shall be provided with an overspeed capability of 125% and less than 5% wave form deviation.

- E. The generator shall be furnished with a permanent, magnet exciter to force the field during short-circuit conditions. The generator shall be capable of sustaining a minimum of 300 percent rated current for ten (10) seconds under short-circuit conditions.
- F. Provide a unit-mounted, enclosed molded case circuit breaker with adjustable long & short time and instantaneous trip settings and a short-circuit rating compatible with the rating of the generator. Provide long-time and short-time time delays.
- G. Provide ground fault indication equipment. Ground fault relay shall be factory installed with a ground fault alarm lamp on the generator control panel. Provide a reset switch and test switch on the generator control panel. Provide one (1) set of form "C" contacts for remote monitoring. Send signal to generator control panel and generator remote annunciator panel.

2.05 CONTROL PANEL

- A. Control panel shall be unit-mounted using vibration isolators. All controls shall be resistant to moisture and vibration.
- B. Provide two-wire start-stop control for remote connection to ATS and local manual control. Provide three-position AUTO-OFF-RUN selector switch. In the AUTO position, start stop functions shall be controlled from the transfer switch system. In the OFF position, the unit shall not start under any conditions. In the RUN position, the unit shall start and run regardless of the status of the remote start circuit. All safety shut-off devices and circuits shall be operative in both the AUTO and RUN positions. The OFF position shall be used for reset of shut-off alarms.
- C. Provide required relays for fire alarm system monitoring of the Generator per NFPA 101 (generator running, gen not in auto, generator fault).
- D. Provide required control interface with air intake and exhaust dampers to ensure that they open whenever the generator starts.
- E. Provide interface with load bank shunt trip circuit breaker in adjacent distribution panel. Provide any required signals to ensure that the load bank breaker trips whenever the normal voltage on either ATS falls below set point (causing a generator start signal from the ATSS). Alternatively, the signal can be sent to the shunt trip breaker from the ATS. Provide wiring diagrams of complete system for review.
- D. The control panel shall include the following instrumentation:
 - 1. Digital ammeter, voltmeter and frequency meter.
 - 2. Digital power factor meter.
 - 3. Frequency meter, pointer or digital type, +/- 2 percent, 45-65 Hz scale.
 - 4. Panel illuminating lights.

5. Running time meter, 0-9999 hours.
6. Battery charging meter.
7. Alarm panel to indicate low oil pressure, high water temperature, engine overload, overcrank, overspeed, low battery voltage, critical low fuel level, fuel leak, fuel send failure, battery charger failure, battery overvoltage. Provide audible alarm with silence pushbutton. Alarm panel shall satisfy NFPA 110, Level 2 requirements.
8. Engine start/stop selector switch.
9. Output voltage adjustment.
10. Controller should be able to be programmed and shall be windows based. It shall be capable of recording up to 30 events. SAEJ 1939 communications capability shall be provided.
11. Provide both local and remote emergency shut down switches.

2.06 REMOTE ANNUNCIATOR PANEL

- A. NFPA 110, Level 2 requirements for remote annunciation shall be satisfied by a remote mounted panel. Provide lamp test and alarm silence switches.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor shall be completely responsible for installing the engine-generator in the space shown ensuring that code required working space is available around the equipment.

3.02 TESTING AND CERTIFICATION

- A. After fabrication in the manufacturer's plant, an operational test shall be conducted to check out the entire system before delivery.
- B. After installation, the manufacturer shall provide the services of a competent factory based service engineer to coordinate the installation of the engine generator system. He shall assist in placing the equipment into operation and provide instruction as required to the person or persons who are delegated to operate the equipment.
- C. The manufacturer of the generator shall inspect and verify the correct installation of the generating system. All individual components including, but not limited to, the engine, generator, fuel tank, battery, battery charger, mechanical air dampers, load bank shunt trip operation, and silencer shall be checked. Power conductors and control circuits shall also be checked.
- D. The manufacturer of the generator set shall provide the services of a qualified technician for initial start-up. Checks and services shall be conducted to prepare all equipment for start-up. All alarm circuits and safety shutdown circuits shall be checked. The technician shall follow a routine start-up procedure as recommended by the equipment manufacturer.

- E. An independent testing firm shall perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for “AC Generators and for Emergency Systems” specified in NETA Acceptance Testing Specification. Certify compliance with test parameters. Tests shall be performed in conjunction with the load bank and generator associated mechanical systems (air intake and exhaust dampers).
- F. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified, including, but not limited to, single-step full-load pickup test.
- G. Coordinate tests with tests for transfer switches and run them concurrently.
- H. Field service must be unlimited and must continue until satisfactory system operation and customer approval has been achieved.
- I. Operating and maintenance instructions shall be provided. Instructions shall be provided in accordance with Division-16 Section, Basic Electrical Materials and Methods.
- J. The manufacturer shall warrant the equipment specified herein to be free from defects in material or workmanship. In the event any defects are discovered within 24 months from start-up or 30 months from date of delivery, the manufacturer shall perform repairs or replacement, at its own option, of any defective products at no cost to the Owner.
- K. Generator shall be tested to ISO 8528-5 for transient response.
- L. Generator shall be tested to ISO 8528-10 for sound data (with infinite exhaust).

3.03 DEMONSTRATION

- A. Provide a minimum of 8 hours of training for owner’s staff. Training shall be video recorded and the digital recording shall be provided to the owner for their use. Two digital copies of the training shall be provided.

3.04 FUEL

- A. At the conclusion of the project, after all testing is complete and the generator has been accepted by the Owner, the fuel tank must be filled to capacity. All fuel consumed during testing must be replaced and the tank must be full.

END OF SECTION 16230

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. The Contractor shall furnish and install a permanently mounted load bank in a weatherproof enclosure, forced air cooled with remotely mounted control panel.
- B. The load bank shall comply with the latest applicable NEMA, NEC and ANSI standards. The load bank shall be listed to UL standard 508A.

1.03 SUBMITTALS

- A. Submit manufacturer's data sheets, wiring schematics installation dimensional drawings for Owner/Engineer, review, comments, and/or approval.
- B. Identify all specified items on submittals to assure compliance and ease of review and/or approval.
- C. Prior to final test and acceptance, submit final data sheets, schematics and dimensional drawings in neat brochure form.
- D. Submittal Data Required:
 - 1. Technical data including features performance, electrical characteristic, physical characteristics, ratings, accessories, and finishes.
 - 2. Complete installation drawings, including dimensional plans, front and side elevations and mounting details.
 - 3. Load bus configuration and load connections termination area shall be clearly identified.
 - 4. Actual electrical schematic shall be provided to detail the operation of the load bank and the provided safety circuits. Over-current protection and control devices shall be identified and their ratings marked. A system interconnection drawing shall be included for control wiring related to the load bank.
 - 5. Operation and Maintenance Manuals
 - a. Installation and operation manuals shall be provided with the equipment and shall include complete details for the installation, commissioning, operation, and maintenance of the load bank.
 - b. The manuals shall include the electrical schematic and interconnect drawings for the power and control wiring for the load bank and all control devices.
 - c. A complete parts list with part numbers, device identification, and rating shall be included in the manuals. The original manufacturers name and part number shall be included in the

- d. parts listing.
Two (2) sets of manuals shall be provided with the load bank.
6. The manufacturer shall submit a copy of the specifications with each sub-paragraph noted with the term, "compliance", "deviation", or "alternate".
- a. By noting the term "compliance" it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - b. By noting the term "deviation" it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
 - c. By noting the term "alternate" it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.

1.04 QUALITY ASSURANCE

- A. All components of and the complete installation of the diesel generator and load bank system shall comply with all applicable requirements of the National Electrical Code relating to emergency and standby power systems.
- B. Qualifications of Manufacturer.
 - 1. The load bank shall be manufactured by a firm regularly engaged in the manufacture of load banks and who can demonstrate at least fifteen (15) years experience with at least ten (10) installations of load banks similar or equal to the ones specified herein.
 - 2. The manufacturer shall have a written Quality Control procedure available for review by the purchaser, which will document all phases of operations, engineering, and manufacturing
 - 3. Manufacturer must have a field service organization with service personnel having a minimum of an Associate Degree in Electrical Engineering.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Avtron or approved equal.

2.02 RATINGS

- A. The total capacity of the load bank shall be rated 150 KW at 240 Volts, 1-Phase,

3-Wire, 60 Hertz, 625 Amps per Phase at unity Power Factor and 5 KW minimum load step resolution.

- B. The load bank shall be designed for continuous duty cycle operation with no limitations. The load bank shall operate in an ambient temperature of -28°C to 49°C (-20°F to 120°F).

2.03 MATERIAL AND CONSTRUCTION

- A. The load bank shall be outdoor weatherproof construction, suitable for installation on a concrete pad or structural base. All exterior fasteners shall be stainless steel. The load bank shall include forklift channels in the base for lifting.
- B. The load bank shall be constructed of heavy gauge aluminized steel per ASTM A463. Aluminized steel provides superior corrosion protection and extended service life, with a better tolerance to high heat exposure compared to the more common Galvanized steel.
- C. The main input load bus, load step relays, fuses and blower/control relays shall be located within the load bank enclosure. A thermostatically controlled heater shall be located within the control section to provide protection to the control devices from the effects of moisture and condensation.
- D. Airflow throughout the load bank shall be horizontal. Intake openings shall be designed to prevent objects greater than 0.50" diameter from entering the unit.
- E. The load bank exhaust hood shall be angled downward. The exhaust hood shall be constructed of non-corrosive aluminized steel or aluminum.
- F. The load bank enclosure shall have a baked polyester powder coated finish with a film thickness of 2.8 +/- 0.4 Mils per coat.
- G. Load elements shall be contained in an integral resistor case. Resistors can be individually removed for inspection or service.

2.04 RESISTIVE LOAD ELEMENTS

- A. Load elements shall be Avtron Helidyne™, helically wound chromium alloy rated to operate at approximately ½ of maximum continuous rating of wire. Elements must be fully supported across the entire length within the air stream by segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short circuit to adjacent elements or to ground.
- B. The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.
- C. The overall tolerance of the load bank shall be -0% to +5% KW at rated voltage. A -5%, +5% rating allows the load bank to deliver less than rated KW and shall not be used. The load bank must deliver full rated KW at rated voltage.

2.05 COOLING

- A. The load bank shall be cooled by integral TEFC or TEAO motor(s) which is direct coupled to the cooling fan blade. The fan motor must be electrically protected against overload using a motor overload device and short circuit protected using two (2) current limiting fuses with an interrupting rating of 200K A.I.C.
- B. The fan blade is to be an airfoil design constructed from aluminum or non-corroding material.

2.06 PROTECTIVE DEVICES

- A. A differential pressure switch shall be provided to detect air loss. The switch shall be electrically interlocked with the load application controls to prevent load from being applied if cooling air is not present.
- B. An over-temperature switch shall be provided to sense the load bank exhaust in the heater case assembly. The switch shall be electrically interlocked with the load application controls to remove load from being applied in the event of an over temperature condition.
- C. To provide for major fault protection, branch fuses shall be provided on the phases of switched load steps above 50KW. Branch fuses shall be current limiting type with an interrupting rating of 200K A.I.C.
- D. The exterior of the load bank shall have appropriate warning/caution statements on access panels.

2.07 CONTROL PANEL

- A. The control panel shall be a remote 19" rack mounted panel housed in a NEMA 4 type wall mount enclosure. The control panel shall contain the following manual controls:
 - 1. Power ON/OFF switch
 - 2. Blower START/STOP pushbuttons.
 - 3. Master load ON/OFF switch.
 - 4. Load step switches for ON/OFF application of individual load steps.

Control panel visual indicators shall be as follows:

- 1. Power ON indication light.
 - 2. Blower ON light.
 - 3. Blower/Air FAILURE light.
 - 4. OVERTEMPERATURE light.
- B. A standard remote load dump circuit shall be provided as part of the load bank

control circuit. Provisions shall be provided to remove the load bank off-line from the operation of a remote normally closed set of auxiliary contacts from a transfer switch or other device. In the event of the remote contact opening, all load is removed.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor shall be completely responsible for installing the load bank in the space shown ensuring that code required working space is available around the equipment. Ensure that supplier recommended clearances for air flow are met.

3.02 TESTING AND CERTIFICATION

- A. All testing shall be by an independent testing firm.
- B. Testing shall be done concurrently with generator testing. Test specification shall be submitted along with the contractors bid.
- C. The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value.
- D. The manufacturer shall maintain this data on file for inspection purposes by the purchaser. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame. Tests of all safety circuits shall be performed to verify conformance to the specification
- E. All electrical circuits shall have a high potential insulation resistance test performed at twice rated voltage plus 1000 VAC to assure insulation integrity.
- F. All quality control test equipment shall be regularly maintained and calibrated to traceable national standards.
- G. The Company's Quality System shall be ISO 9001 Certified

3.02 DEMONSTRATION

- A. Provide a minimum of 8 hours of training for owner's personnel. Training shall be provided by a factory certified technician. Provide a DVD recording of training for future use.

END OF SECTION 16230

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, “Basic Electrical Materials and Methods”, apply to this Section.

1.02 SUMMARY

- A. The Contractor shall furnish and install the medium voltage transformers as specified herein, as indicated on the Drawings and as required for a complete installation.

1.03 SUBMITTALS

- A. Provide product data for the medium voltage transformer. Submit data sheets, wiring diagrams, and dimensional drawings for approval.
- B. Provide a copy of the manufacturer's standard test report for a transformer of the same rating as the unit specified.
- C. Qualification data for Testing Agency.

1.4 QUALITY ASSURANCE

- A. The transformer shall comply with and shall be installed in accordance with the latest edition of the following standards:
 - 1. NFPA 70 "National Electrical Code".
 - 2. ANSI C2 "National Electrical Safety Code".
 - 3. Applicable ICEA, NEMA, AEIC and UL Standards.
- B. The transformer shall meet all the requirements as needed for FM Global Approval and NEC 450.23.
- C. All products shall be by the same supplier.

PART 2 - PRODUCTS

2.01 TRANSFORMER

- A. Provide unit by Cooper/Eaton: Peak™ Single Phase Pad Mounted Transformers or approved equal.
 - 1. Basis of Design Dimensions are 30” H x 36.25”W x 46”D. Six foot clear is required in all sides. These clearances must be maintained.
- B. The ratings of the transformer shall be as follows or as shown on the drawings:
kVA Rating: 167 kVA (without the use of fans – OA cooling system)

Impedance: Minimum 1.2% +/- 7-1/2%
HV: 7,200 V, single phase (confirm with Utility prior to Order).
HV BIL: 95 KV
HV Taps: Two +/- 2-1/2% full capacity
LV: 240/120 V, single phase, 3 wire
LV BIL: 30 KV

- C. Insulating Liquid: Less flammable, edible-seed-oil based, FM Global Approved, and UL listed as complying with NFPA 70 requirements for fire point of not less than 360 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic. Provide Envirotemp FR3 or approved equal.
- D. The transformer shall carry its continuous rating with average winding temperature rise by resistance that shall not exceed 150°F (65°C), based on average ambient of 86°F (30°C) over 24 hours with a maximum of 104°F (40°C).
- E. The transformer shall be designed to carry short time emergency overloads in accordance with ANSI C57.12.92 as applicable. Duration and magnitude of designed withstand capability shall be as outlined in ANSI C57.12.90 and the latest draft of the IEEE Short Circuit Test Code.
- F. The transformer shall be dead-front, radial feed and shall incorporate HV and LV terminals. Cabinet shall be 16" deep. A padlockable handle shall be provided for securing the cabinet. Hinges and mounting studs shall be stainless steel.
- G. Features and accessories shall include: cover mounted, externally operated, padlockable handle; tap changers; two position load break switch, 200A HV bushing wells; drain / sampling valve and plug; filling provision with plug; magnetic liquid level gauge; oil temperature gauge, provisions for lifting; provisions for jacking; base designed for skidding or rolling in two directions; ground pads; instruction nameplate; main tank cover; and automatic pressure relief device that automatically reseals after operation.
- H. All high voltage windings shall have nomex wrapped insulation prior to winding the coils. Insulation between layers of the windings shall be by Insuldur paper or equal.
- I. Primary Fuses: 15-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
 - 1. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
 - a. Fuse amperage rating shall be per recommendations in the coordination / arc flash study. Coordinate with study provider prior to submitting transformer data for Engineer review.

2. Provide single on/off load/break switch under oil for radial feed applications. Withstand/close-on rating shall be 12.5 kA symmetrical.
- J. Surge Arresters: Dead Front Metal-Oxide Varistor type, Distribution class, one for the primary phase; complying with IEEE C62.11 and NEMA LA 1; connect to second HV bushing (in parallel with first HV bushing). Voltage rating shall be per supplier recommendations at 7.2 kV grounded primary voltage. Provide separable elbow type arrestors.
- K. The core and coil assembly shall be wound core type with copper windings.
- L. The main transformer tank and attached components shall be designed to withstand pressures 25% greater than the required operating design value without permanent tank deformation. Construction shall consist of stainless steel plate reinforced with external sidewall braces. All seams and joints shall be continuously welded. Tank and accessories shall adhere to these requirements and those required by FM Global for approval, whatever is more stringent.
- M. Each radiator assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six (6) hour leak test shall be performed after the transformer is tanked, welded and completed to ensure that there are no leaks before shipment.
- N. Each transformer shall be painted utilizing an initial phosphatizing cleaning treatment, followed by manufacturers standard paint process baked on to a total of three to five mils average thickness. Paint Munsell Green.
- O. The transformer shall be designed to meet the sound level standards for liquid transformers as defined in NEMA TR1. Outdoor liquid transformer units shall include suitable outdoor paint finish and parking stands.
- P. The unit shall be provided with a removable bottom sill to permit sliding the transformer over conduit stub-ups.
- Q. Primary bushings shall be externally clamped universal wells with 200A loadbreak inserts. Provide all accessories for terminating medium voltage cable at dead-front transformer. Provide 200A loadbreak elbow. A total of two (2) bushings shall be provided. The first set will have the primary phase conductor terminated on it utilizing a separable elbow. The second set will be used for elbow type surge arrestors. Provide a minimum of one (1) parking stand. The primary winding shall be 7,200 volts to ground. Connect the primary cable neutral connection to the transformer ground bar.
- R. Secondary bushings shall be low voltage molded or porcelain bushings, externally clamped with a spade-type terminal. Include provisions for terminating all required conductors per the drawings.
- S. Unit shall meet DOE 2016 Efficiency Requirements.

- T. The following factory tests shall be made on all transformers, although not necessarily in the order listed. All tests shall be in accordance with the latest revision of ANSI Test Code C57.12.90 and NEMA TRI.
1. Resistance measurements of all windings at the rated voltage and at the tap extremes.
 2. Ratio tests at the rated voltage and on all tap connections.
 3. Polarity and phase-relation tests at the rated voltage
 4. No-load loss at rated voltage.
 5. Exciting current at rated voltage.
 6. Impedance and load loss at rated current at the rated voltage and on the tap extremes.
 7. Temperature tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.
 8. Applied potential test.
 9. Induced potential tests.
- Results of the above tests including no load loss data shall be submitted with final drawings in the form of certified test reports.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Medium voltage transformer shall be installed in strict accordance with manufacturer's instructions and industry practices.
- B. Terminate medium voltage cable and 600 volt power cable as specified herein and as specified in applicable sections of this specification.
- C. Coordinate installation with pad. Coordinate all work with Civil/Structural. Coordinate pad size per final dimensions. Pad shall be at least 4" wider than equipment on all sides. Refer to Civil/Structural Drawings for pad details.
- D. Connect all accessory grounds, cable shields, equipment grounds, ground ring connections, etc. as needed to the ground pad. Provide full copper ground bars if needed to adequately make terminations.

3.2 ADJUSTING

- A. Two months after substantial completion, visit site, measure voltage, and adjust taps as required to obtain 250/125 VAC at Main Service Entrance. Test during normal hours. Adjust taps after hours. Coordinate with the owner for scheduling the outage.

3.3 TESTING

- A. After installation and prior to energization, the transformer shall be tested in accordance with the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems", latest edition, as published by the InterNational Electrical Testing Association.

- B. Total combustible gas measurements and dissolved gas analysis are required to be performed on the insulating oil.
- C. All testing shall be conducted by an independent testing agency as specified in Division-16 Section, "Inspections, Testing and Start-up." Submit copies of the test reports for approval.
- D. Provide ground potential testing per Grounding Specification.
- E. Provide a copy of the approved test report in the operating and maintenance manuals specified in Division-16 Section, "Basic Electrical Materials and Methods."

END OF SECTION 16275

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, "Basic Electrical Materials and Methods", apply to this Section.

1.02 SUMMARY

- A. The Contractor shall furnish and install circuit and motor disconnect switches where indicated on the Drawings and where required by the National Electrical Code, local codes and the authority having jurisdiction.

1.03 SUBMITTALS

- A. Provide product data for each type and rating of circuit and motor disconnect switch.

1.04 QUALITY ASSURANCE

- A. Circuit disconnects and motor disconnect switches and the installation of same shall comply with the requirements of NFPA 70, "National Electrical Code."
- B. Circuit and motor disconnect switches shall be listed and labeled by UL.

PART 2 - PRODUCTS

2.01 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Switches shall be constructed in accordance with the latest editions and revisions of NEMA Standard KS-1, Federal Specification W-S-685C, and Underwriters' Laboratories Standard 98.
- B. Switches shall be fusible or non-fusible as indicated on the Drawings, or as required by the equipment served, horse-power rated, quick-make, quick-break, heavy-duty type with integral arc suppressors. The handle shall be part of the enclosure, not the cover.
- C. Fused switches and fuses shall have a minimum integrated interrupting rating of 100,000 amperes RMS symmetrical.
- D. Switches 800 amperes and larger shall be bolted pressure type.
- E. Switches used for service entrance shall be service rated and bear the UL service entrance label.
- F. Switches shall have general purpose surface mounted NEMA type 1 or 3R enclosures as indicated or required by locations. All enclosures shall be designed to permit padlocking in the "open/off" position.

- G. Switches on 120/240 volt service shall be rated 240 volts.
- H. Fused switches for motor applications shall be furnished with UL listed dual-element Class RK-1 time delay fuses rated 600 volts. Fuse current ratings shall be as indicated on the Drawings or in accordance with the motor manufacturer's recommendations when specific sizes are not specified on the Drawings.
- I. All exterior mounted units shall be lockable.

2.02 CONTROLS

- A. Push buttons shall be momentary contact, heavy duty, oiltight with legend plate. Buttons shall be fully guarded and shall be red in color.
- B. Selector switches shall be two position, heavy duty, oiltight with legend plate.
- C. Contact blocks shall be provided as required for all push buttons and switches. Contacts shall have a 10 ampere continuous current rating at 120 VAC or 120 VDC except where indicated otherwise.
- D. Control stations shall be recessed with sufficient space to accommodate operators as required. Provide stainless steel NEMA 1 flush cover plates.

2.03 ACCESSORIES

- A. Provide electrical interlocks where indicated on the Drawings.
- B. Provide one normally open and one normally closed auxiliary contact on each switch. Auxiliary contacts shall be rated 10A, 120 VAC.
- C. Fused disconnects and switches shall be provided with integral built-in fuse pullers arranged to facilitate fuse removal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Switches shall be coordinated with the equipment to provide switches to suit the particular equipment characteristics and requirements.
- B. Provide fusible switches for all equipment labeled for and/or requiring fuse protection.
- C. Switches shall be installed in accordance with manufacturer's published instructions.
- D. Provide three (3) spare fuses of each type and rating furnished for this project. Deliver spare fuses to the Owner's place of storage.
- E. On the exterior, mount disconnect switches at 72" AFG UON.

3.02 TESTING

- A. Prior to energizing circuits and switches, test wiring for electrical continuity and short-circuits.

END OF SECTION 16410

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes molded-case circuit breakers in individual enclosures.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches

1.03 SUBMITTALS

- A. Division-1 Sections.
- B. Product Data: Submit catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

PART 2 - PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER

- A. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1 with interrupting capacity to comply with available fault currents, and suitable for use as service entrance equipment where applied.
- B. Accessories: Conform to NEMA AB 1.
 - 1. Handle Lock: Provisions for padlocking (NEMA 12 enclosure)
 - 2. Grounding Lug: In each enclosure
- C. Enclosed circuit breakers shall have general purpose, surface mounted, NEMA Type 1 or 3R enclosure as indicated or required by location.
- D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
- E. Service Entrance: Enclosed circuit breakers identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- F. Circuit breakers shall be fully rated. Series rated withstand are prohibited.
- G. All units shall be lockable if located outside.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install enclosed circuit breakers plumb. Provide supports in accordance with Division-16 Section, "Supporting Devices."
- B. Height: 6 feet to operating handle.
- C. Locate and install engraved plastic nameplates in accordance with Division-16 Section, "Basic Electrical Materials and Methods."

3.02 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with National Electrical Testing Association (NETA).

END OF SECTION 16412

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. This specification describes the requirements associated with the automatic transfer switches and associated control devices as indicated on the drawings and as specified herein. The automatic transfer switches shall be manufactured, installed and tested in strict accordance with these specifications.

1.03 SUBMITTALS

- A. Submit the following information for Owner/Engineer review, comments and/or approval:
 - 1. Product data.
 - 2. Complete installation drawings, including plan view and elevations with connection of required utilities clearly indicated.
 - 3. Electrical schematics, wiring diagrams, interconnection diagrams and bussing details.
 - 4. Statement of compliance and deviation as specified herein.
- B. The manufacturer shall submit a copy of these specifications with each subparagraph noted with the comment "compliance", "deviation", or "alternate".
 - 1. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - 2. By noting the term "deviation", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
 - 3. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.
- C. Identify all specified items on submittals to assure compliance and ease of review and/or approval.

1.04 QUALITY ASSURANCE

- A. The automatic transfer switches shall conform to these specifications and applicable codes and standards published by the following authorities and associations:
 - 1. National Fire Protection Association (NFPA)

2. Underwriter Laboratories (UL), UL 1008
3. NFPA 70, National Electrical Code (NEC)
4. American National Standards Institute (ANSI)
5. National Electrical Manufacturers Association (NEMA)
6. American Society of Testing and Materials (ASTM)
7. Institute of Electrical and Electronics Engineers (IEEE)

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCHES

- A. The automatic transfer switch shall be factory assembled with the current ratings, voltages and accessories as indicated on the drawings or specified herein.
- B. The switch and all of its associated controls and terminations shall be completely front accessible.
- C. The switch shall be mechanically held in both the normal and the emergency positions, and rated for continuous duty in an unventilated enclosure. The switch shall be open transition, break-before-make, double throw with the main contacts rigidly and mechanically interlocked to insure three possible positions: Normal, Emergency or Neutral.
- D. The automatic transfer switch shall be of the motor or solenoid type. Circuit breaker type switches are not acceptable and will not be considered.
- E. The ATS shall be UL listed, STD UL-1008, with withstand and close-in values which match the overcurrent protective devices for the normal and emergency feeders.
- F. The ATS shall be provided in a NEMA type 1 enclosure suitable for the location where the switch will be installed.
- G. All bus shall be copper.
- H. The ATS shall have a withstand rating equal to the AIC ratings of the circuit breakers from which it is served. 65KAIC minimum at 240V AC.
- I. The ATS shall be 240/120V, 800A, single phase, service entrance rated, and shall have a switched neutral.
- J. Basis of design is ASCO 300 SE Series.

2.02 ACCESSORIES

- A. The ATS shall be provided with the following accessories:
 1. Adj. 0.5-3 second time delay on engine start.
 2. Adj. 1-300 second time delay on transfer to emergency.
 3. Adj. 0-30 minute time delay on transfer to normal.

4. Fixed 5 minute time delay for engine cool-down.
 5. Load test switch, maintained type.
 6. One (1) contact to open and one (1) contact to close on failure of normal to be used for engine starting.
 7. Pilot lights to indicate switch position.
 8. Two (2) auxiliary contacts closed in normal.
 9. Two (2) auxiliary contacts closed in emergency.
 10. Adjustable close differential voltage sensing on all phases of normal, pick-up set at 90%, drop-out set at 85% of nominal.
 11. Voltage and frequency sensing of emergency source, voltage pick-up set at 90%, frequency pick-up set at 95% of nominal.
 12. An automatic seven (7) day exerciser clock, enabling the engine to be automatically started and run without load for thirty (30) minutes each week at a preprogrammed time period. The transfer switch shall remain in the "normal" position unless a commercial power failure occurs during the exercise period.
 13. Provide remote annunciator panels for each switch. Locate as shown on the drawings.
- B. The ATS shall have an open transition time between the opening of the closed contacts and the closing of the open contacts adjustable from 1-300 seconds.
- C. The ATS shall be equipped with a safe manual operator. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator. The manual operator shall be operable with the ATS door in the closed position.
- D. All relays, timers, control wiring shall be front accessible. All adjustable time delays shall have calibrated marks for field adjustments. Time delay relays/circuits which cannot be accurately set in the field without the use of test equipment are not acceptable.
- E. Provide integral or modular surge protection. Refer to surge protective devices specification. Provide factory or field installed 60A circuit breaker for SPD protection. Use 3#6 & 1#6grd in 1" conduit for connection.

2.03 OPERATION

- A. Upon loss of normal power and after an adjustable time delay, the switch shall signal the standby generator to start.
- B. The transfer switch shall transfer to emergency when the output of the standby generator reaches 90% of rated voltage and 95% of rated frequency. If the emergency source is not available, or if the generator voltage is less than 90% nominal, transfer to emergency shall be inhibited.
- C. After the normal source has been restored to 90% of rated voltage, the transfer switch shall retransfer to the normal source after an adjustable time period of 0 to 30 minutes.

- D. The standby generator shall continue to run unloaded for five (5) minutes and then shutdown. All controls shall automatically reset in preparation for the next power failure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the automatic transfer switches in the space shown.
- B. Connect auxiliary and control contacts in ATS to the engine-generator control panel in accordance with the engine-generator manufacturer's instructions.
- C. Connect auxiliary and control contacts in ATS to the fire alarm annunciators and controls in accordance with the fire alarm instructions.

3.02 TESTING AND CERTIFICATION

- A. Test and demonstrate to the Owner's representative (with factory representative present) that the transfer switch meets the requirements of this specification.
- B. Demonstration shall include, but not be limited to, the operation of all time delays, starting contacts, and transfer functions.
- C. All testing shall be scheduled at the convenience of the Owner, and shall be arranged at least two (2) weeks in advance.
- D. Services shall include a minimum of two (2) visits by representatives of the ATS manufacturer as follows:
 - 1. Following installation, the manufacturer of the ATS shall inspect and verify the correct installation of the ATS. All individual components shall be checked. Power conductors and control circuits shall also be checked.
 - 2. The manufacturer of the ATS shall provide the services of a qualified technician for initial start-up. Checks and services shall be conducted to prepare equipment for energization.
 - 3. Field service must be unlimited and must continue until satisfactory system operation and customer approval has been achieved.
 - 4. Prior to system turnover, an instruction period for operation shall be provided.
- E. Final data sheets, schematics, dimensional drawings, and operating and maintenance instructions shall be provided. This information shall be provided in the operating and maintenance manuals specified in Division-16 Section, Basic Electrical Materials and Methods.

END OF SECTION 16415

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this section.

1.02 SCOPE

- A. The Contractor shall furnish and install the Surge Protective Devices (SPD) equipment having the electrical characteristics, ratings and modifications as specified herein and/or as shown on the contract drawings.
- B. Provide new modular surge protective devices on each main 240V distribution panel and on automatic transfer switches as indicated on drawings.
- C. References: The SPD units and all components shall be designed, manufactured and tested in accordance with the latest applicable UL listed standards (UL 1449, 4th Edition), UL 1283, and CSA certified per CSA 22.2. UL Standard 1449, 4th Edition takes precedence over all other Standards.

1.03 SUBMITTALS

- A. The following information shall be submitted to the Engineer:
 - 1. Provide verification that the SPD device complies with the required UL 1449 4th Edition and CSA approvals.
 - 2. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 and C1 (combination wave) and B3 (ringwave) tested in accordance with ANSI/IEEE C62.45.
 - 3. For retrofit mounting applications, drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
 - 4. Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the IEEE C62.41, 8 x 20 microsecond current wave. Note that test data on individual module is not accepted.
 - 5. Joule ratings shall not be acceptable in lieu of UL 1449 4th Edition test data.
 - 6. Descriptive bulletins.
 - 7. Product sheets.
 - 8. Final record drawings.

1.04 QUALIFICATIONS

- A. The manufacturer must have a 24-hour response capability with field engineering personnel. The field service organization must have fully accredited Power System Engineers located across the USA/Canada who are capable of performing complete grounding and Power Quality analysis. Factory trained SPD sales personnel do not qualify as Power System Engineers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Square D: Surgelogic EMA Series or approved equivalent.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements:

1. Unit Operating Voltage: Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV): The MCOV shall be greater than 115% of the nominal system operating voltage.
3. Protection Modes: For a wye configured system, the device must have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), line-line (L-L), and neutral-ground (N-G).
4. UL 1449 4th Edition VPR: The maximum UL 1449 4th Edition VPR for the device must not exceed the following:

Modes	240/120 Volt
L-L	1200 V
L-N; N-G; L-G	800 V

B. SPD Design:

1. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
2. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283. Products not able to demonstrate noise attenuation of 55 dB @ 100 kHz shall be rejected.
3. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
4. Safety and Diagnostic Monitoring: Each unit shall be equipped with 200 kAIC internal fuses. Each unit shall provide the following three (3) levels of monitoring:
 - a. Continuous monitoring of fusing system.
 - b. Internal infrared sensor system for monitoring individual MOVs (including neutral to ground). The system must be capable of

identifying open circuit failures not monitored by conventional fusing systems.

- c. Thermal detection circuit shall monitor for overheating in all modes due to thermal runaway.
 - d. A green/red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged. Fault detection will activate a flashing trouble light. Units which cannot detect open-circuit damage, thermal conditions and over current will not be accepted.
5. Remote Status Monitor: The SPD must include form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three (3) monitoring systems described detect a fault condition.

2.03 SYSTEM APPLICATION

- A. The SPD applications covered under this section include switchboard assemblies and branch panels.
- B. Surge Current Capacity: The minimum total surge current 8 x 20 microsecond waveform that the device is capable of withstanding shall be as shown in the following table:

<u>Application</u>	<u>Min. Surge Current Per Phase</u>	<u>Min. Surge Current Per Mode*</u>
(EMA Series) Service Entrance Automatic Transfer Switches And Main Distribution Panels	240 kA	120 kA

- C. Retrofit Installation (externally mounted suppressor). Maximum conductor lead length between breaker and suppressor shall not exceed 24 inches. Comply with manufacturer's recommended installation and wiring practices.
- D. Distribution Panel and ATS Requirements:
 - 1. The service entrance SPD shall be tested and suitable for ANSI/IEEE C62.41 Category C3 environments.
 - 2. Locate suppressor on load side of main disconnect device, as close as possible to the phase conductors and ground/neutral bar.
 - 3. Provide a 60 amp disconnect.
 - 4. It shall be permissible to provide the SPDs for the ATSS integral to the ATSS themselves. If this is done, they shall be factory installed.

2.04 ACCESSORIES

- A. Push to test feature to verify operational integrity.

- B. Form C dry contacts one (1) NO, one (1) NC for remote status monitoring.
- C. Provide audible alarm and surge counter as shown on the contract drawings.

2.05 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 - 1. NEMA 1 surface or flush-mounted general purpose enclosures primarily intended for indoor use.

PART 3 - EXECUTION

3.01 EXAMINATION

3.02 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.03 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

END OF SECTION 16416

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.
- B. Cabinets and enclosures shall conform to Division-16 Section, Boxes, Fittings and Cabinets.

1.02 SUMMARY

- A. Furnish and install panelboards, cabinets and boxes as indicated on the Drawings and as specified herein.

1.03 SUBMITTALS

- A. Provide product data for all panelboards, enclosures, cabinets, overcurrent devices and accessories.
- B. Provide time-current-characteristic curves for all phase overcurrent devices rated 100 amperes or more and for all ground fault protective devices.

1.04 QUALITY ASSURANCE

- A. Panelboards shall be supplied and installed in strict conformance with NFPA 70, National Electrical Code.
- B. Products supplied under this Section shall comply with applicable requirements of UL standards pertaining to panelboards, overcurrent devices, enclosures, and cabinets. Completed assemblies shall be UL listed and labeled.

PART 2 - PRODUCTS

2.01 PANELBOARDS

- A. Panels shall be of the circuit breaker type, and shall have capacity and arrangement as shown on the panel schedules or one-line diagram.
- B. Branch circuit breakers shall be bolt-on type and shall be of the ambient compensated, thermal magnetic type, which will provide inverse time delay overload, and instantaneous short circuit protection. Branch circuit breakers shall have one, two or three poles as designated on the panel schedule. No circuit breakers utilizing handle ties for two or three pole operation shall be acceptable. Voltage and current ratings shall be as indicated on the drawings.
- C. Refer to panel schedules on drawings for exact circuit breaker arrangements and interrupting capacities. Provide circuit breakers UL listed as type HACR for air conditioning equipment branch circuits.

- D. Main breakers and branch breakers shall have the same minimum ampere interrupting capacity. Series rating shall not be acceptable.
- E. Provide a typewritten directory for each panel, placed inside the panel door. The directory shall list all rooms served by each breaker, using the "Owner's" room numbers. Directories shall be installed in a metal directory frame under glass or minimum 0.03 (.75 mm) inch thick clear non-yellowing plastic. Spares and spaces shall be written in pencil.
- F. All circuit breakers which serve telephone and communication equipment, refrigerators, exit signs, emergency circuits, fire alarm, security, and other miscellaneous control devices shall be equipped with mechanical handle locking devices.
- G. Each panel shall be equipped with a ground bus, adequate for feeder and branch circuit equipment grounding conductors; bonded to box.
- H. Each panel and cabinet and the units comprising same shall bear the manufacturer's nameplate and the UL label. Panelboards used for service entrance equipment shall be UL Service Entrance rated/labeled.
- I. All single-phase, three-wire panels shall be equipped with a fully rated neutral bar. The neutral bar shall be sized to accommodate oversized neutral conductors where oversized neutral conductors are indicated on the Drawings.
- J. Panels 68 inches or less in height shall be installed with the top of the panel 6 feet above the finished floor. All panels shall be installed in accordance with NEC 404 and 408.
- K. All bus shall be copper.
- L. Cabinet and trim shall be of code gauge steel (minimum) with 4" (100 mm) (minimum) wiring gutter all around. All panelboards shall be equipped with a hinged, locking door and piano hinged trim. Two (2) keys shall be furnished with each cabinet, and all locks on all cabinets shall be keyed alike. Provide door-in-door panel cover. Ensure that doors swing the entire 180 degrees open.
- M. Where panels occur adjacent to one another in finished spaces, cabinets and doors for each panel shall be of the same height.
- N. Panelboards shall be painted with gray over rust preventive primer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount panels in locations shown, making sure that code-required clearances exist.

- B. Where cabinets cannot be set fully flush due to shallowness of partition, trim protruding sides with approved metal or hardwood molding, fastened to cabinet so as to conceal intersection of wall and cabinet.
- C. If paint is damaged during shipping or installation, damaged portion shall be sanded smooth and entire panel repainted.
- D. Provide five (5) spare 3/4" (19 mm) conduits stubbed into accessible ceiling spaces above and below each flush mounted panel.
- E. Load Balancing: After substantial completion, but not more than 60 days after final acceptance, measure load balancing and make circuit changes.
 - 1. Measure loads during periods of normal system loading (coordinate with Owner).
 - 2. Perform load balancing circuit changes outside normal occupancy/working schedule of the Owner at time directed by Owner's representative.
 - 3. After circuit changes are completed, recheck loads during normal load period. Record all load readings before and after changes and submit test results.
 - 4. Tolerance: Difference exceeding 20 percent between phases within a panelboard is not acceptable. Rebalance and recheck as necessary to meet this requirement.

END OF SECTION 16441

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. Furnish and install motor controllers where indicated on the Drawings, where required by the Contract Specifications, and where required for the control and protection of motors as necessary for a complete installation.

1.03 SUBMITTALS

- A. Submit shop drawings and product data for all motor controllers.
- B. Submittals shall include equipment dimensions, power and control wiring diagrams, component descriptions, calculations where required and ratings, and a list of recommended spare parts.
- C. Complete operating and maintenance manuals shall be provided which include technical data sheets, wiring diagrams and information for ordering replacement parts.
- D. The manufacturer shall submit a copy of the specifications with each subparagraph noted with the term, "compliance", "deviation", or "alternate".
 - 1. By noting the term "compliance" it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - 2. By noting the term "deviation" it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
 - 3. By noting the term "alternate" it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.

1.04 QUALITY ASSURANCE

- A. Motor controller components and assemblies shall be furnished and installed in accordance with NFPA 70, National Electrical Code, and shall conform to the requirements of UL 845 and applicable sections of NEMA and ANSI/IEEE standards.
- B. Motor controllers shall be listed and labeled by Underwriters' Laboratories or a Nationally Recognized Testing Laboratory (NRTL).

- C. Source Limitations: Obtain Motor Controllers through one source from a single manufacturer.

PART 2 - PRODUCTS

2.01 FRACTIONAL HORSEPOWER STARTERS

- A. Fractional horsepower manual starters shall be used for single phase motors except where indicated. Single phase starters shall provide across the line starting and overload protection. Single pole and double pole starters shall be used as required and shall be rated not less than 1 horsepower.
- B. Single phase manual starters shall feature snap action double-break contacts, motor running indicating light and trip free melting alloy overload elements selected for the specific motor application.
- C. Single phase manual starters located in mechanical and electrical rooms shall be installed in NEMA 1 general purpose enclosures. Starters located outdoors or in wet locations shall be installed in NEMA 4X watertight enclosures. Starters located in finished areas shall be installed in a flush outlet box and furnished with a stainless steel plate.
- D. Manual motor starters shall be toggle-type and shall be arranged so they may be locked with a padlock in the OFF position.
- E. Oil-tight hand-off-auto selector switches shall be provided where starters are controlled by automatic devices.

2.02 COMBINATION STARTERS

- A. Combination motor starters shall be provided with an integral motor circuit protector specifically designed for motor applications. The MCP shall have a continuous current rating in accordance with NEC Article 430 and shall provide adjustable short-circuit trip settings. The MCP shall have a minimum short-circuit rating of 42,000 amperes at 480 volts.
- B. An external operating handle for the MCP shall be provided. The handle shall clearly indicate the position of the MCP and shall be padlockable in the OFF or OPEN position. Interlocks shall be provided to prevent opening the door when the external operating handle is in the ON or CLOSED position. An interlock defeater shall be provided for use by authorized personnel.
- C. Magnetic-type motor starters shall be used for single phase motors where indicated and for all three phase motors.
- D. Starters shall be full voltage non-reversing (FVNR) or reduced voltage type as indicated on the Drawings. Starters shall utilize three temperature compensated bimetallic overload relays factory set for the specific motor application. Overload relays shall be field adjustable plus or minus 15 percent of the rated trip current. Solid state overload relays are acceptable.

- E. Starters shall be furnished with the following accessories:
 - 1. Hand-off-auto selector switch.
 - 2. Green pilot light to indicate power available to the starter but motor not on.
 - 3. Red pilot light to indicate motor running.
 - 4. Transformer for 120 volt control power (fused primary and secondary).
 - 5. Overload trip indicator and reset.
 - 6. Undervoltage monitor and release.
 - 7. Coils rated 120 volts A.C.
 - 8. Two (2) normally open and two (2) normally closed auxiliary contacts for customer use.
- F. Starters shall be capable of withstanding the let-through short-circuit current of the protective device. Current limiters shall be provided when required to achieve adequate protection from high short-circuit currents.
- G. Where the Drawings indicate individual enclosures for starters, the starters shall be provided in NEMA type 1 enclosures except when noted otherwise on the Drawings. Outdoor starters shall be in NEMA 3R enclosures. All outdoor starters shall be lockable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install motor starters and controllers as indicated on the Drawings, in strict accordance with the manufacturer's written instructions, and in compliance with recognized industry practices.
- B. Install fuses or current limiters when required by the equipment specifications.
- C. Tighten connections and terminations in accordance with the manufacturer's published torque tightening values or in accordance with UL Standard 486A and B when manufacturer's values are not indicated.
- D. Prior to energizing equipment, check power and control wiring for correct installation. After energizing equipment, check each motor for proper phase rotation, correct where necessary, and demonstrate operation of starter and accessories.
- E. Set all MCPs in accordance with manufacturer's instructions. Set all overloads in accordance with motor manufacturer instructions.
- F. All outdoor motor controllers (if applicable) shall be mounted at 72" AFG UON.

3.02 SPARE PARTS

- A. Provide ten (10) lamps of each type and rating supplied with the specified equipment.
- B. Provide one (1) of each type of fuse and current limiter for each ten (10) installed, but not less than three (3) of each type and rating.

END OF SECTION 16445

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Drawings and Division-16 Section, Basic Electrical Materials and Methods, apply to this Section.

1.02 SUMMARY

- A. The extent, location and details of exterior and interior lighting fixtures are indicated on the Drawings, in the schedules and in these Specifications.
- B. The Contractor shall furnish and install all lighting fixtures and shall perform all lighting fixture work indicated.

1.03 SUBMITTALS

- A. Submit manufacturer's product data and installation instructions for each type of lighting fixture specified and each component required for a complete installation.
- B. Submit shop drawings with each type of lighting fixture and all accessories clearly identified.
- C. Submit wiring diagrams for lighting fixtures and accessories including controllers.

1.04 QUALITY ASSURANCE

- A. Comply with applicable requirements of local codes and NEC Articles 220 and 410 as applicable to construction and installation of lighting fixtures.
- B. Comply with applicable NEMA, IES and UL standards. Lighting fixtures and components shall be UL listed and labeled.

PART 2 - PRODUCTS

2.01 LIGHTING FIXTURES

- A. Provide lighting fixtures of the sizes, types and ratings indicated on the Drawings and in the schedules. Fixtures shall be complete with housings, energy efficient drivers, starters, wiring, lenses, louvers and reflectors.
- B. Fixtures shall be factory assembled with all components required for a complete installation.
- C. Wiring within fixtures shall comply with Article 402 of the National Electrical Code; and shall not be smaller than 18 AWG. Wiring in fixtures shall be suitable for connection to branch circuit wiring. Factory supplied whips shall include wiring not less than 12 AWG.

2.02 EMERGENCY LIGHTING

- A. Provide self-contained battery inverter units where indicated on the Drawings and in the schedules. Emergency inverter units shall be internal, factory-mounted except where specifically noted otherwise.
- B. Batteries shall be sealed, spillproof, rechargeable, maintenance-free nickel cadmium or pure lead type.
- C. A solid state constant-current charger shall recharge batteries within twenty-four (24) hours of discharge and shall maintain batteries at a fully charged state during normal operation. A low-voltage disconnect shall prevent deep discharge of the batteries.
- D. A test switch and AC "ON" or unit-ready indicator shall be provided.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lighting fixtures at locations, and at heights as indicated, in accordance with the manufacturer's written instructions to ensure lighting fixtures fulfill requirements.
- B. Fixture installations shall conform to applicable requirements of NEC, NECA "Standard of Installation", NEMA standards and recognized industry practices.
- C. Provide supports, brackets, fixtures and/or fixture outlet boxes with hangers to properly support fixture weight.
- D. Flush mounted fixtures shall be installed to eliminate light leakage between fixture frame and finished surface.
- E. Fixtures shall be secured to structural supports. Pendant fixtures shall be plumb and level. Pendant mounted fixtures, larger than 2 feet (600 mm) shall be installed with two (2) stem hangers. Stem hangers shall have ball aligners and provisions for minimum one inch vertical adjustment.
- F. Surface mounted fixtures greater than 2 feet (600 mm) in length shall be supported from at least one point in addition to the fixture outlet box stud.
- G. Connections and terminations shall be tightened in accordance with equipment manufacturer's published torque tightening values or in accordance with values specified by UL when manufacturer's values are not indicated.
- H. Replace defective and burned out fixtures for a period of two (2) years following the Date of Substantial Completion.
- I. Clean fixtures upon completion of construction.

END OF SECTION 16500

