

SECTION 16010 - BASIC ELECTRICAL REQUIREMENTS

PART I. - GENERAL

A. GENERAL CONDITIONS:

1. The stipulations and conditions stated in this section, together with all provisions of the "Instructions to Bidders", "General Conditions", "Supplemental General Conditions", and "Special Conditions", hereinbefore set forth, shall apply to this and the other sections of Division 16.

B. GENERAL REQUIREMENTS:

1. The General Requirements hereinafter listed apply to the Electrical Work Division. If there is any conflict between the General Requirements and the General Conditions, the General Conditions shall take precedence.

C. ALTERNATES:

1. Carefully examine all alternates at the back of this specification to determine if any work described under the Electrical Section will be affected thereby.

D. INTENT:

1. The intent of these drawings and specifications are to describe the installation of a complete, fully adjusted, and operational system. Therefore, any items shown on drawings and not specifically called for in the specifications, or any items specified and not specifically indicated or detailed on the drawings, or any items neither specified or shown, but which are reasonably incidental to and commonly required to make a complete job, will be furnished and installed by the Electrical Contractor at his own expense.

E. DEFINITIONS:

1. The Electrical Contractor shall provide all supervision, labor, material equipment, machinery, plant, and any and all other items necessary to complete the Electrical systems. All items of equipment are specified in the singular; however, the Electrical Contractor shall provide the number of items of equipment as indicated on the drawings, and as required for complete systems.

Where the word "provide" is used, it shall mean "furnish and install complete and ready to use."

F. VISIT TO THE SITE:

1. The Electrical Contractor shall visit the site before submitting his bid so as to be thoroughly familiar with the job conditions and/or peculiarities. No extra payment will be allowed for anything which could have been anticipated from a visit to the site.

G. REGULATORY REQUIREMENTS:

1. All work under this section shall be accomplished in strict accordance with State codes. Where these plans and specifications conflict with such codes, the codes shall govern. The Electrical Contractor shall notify the Architect or Engineer of such conflicts in writing prior to receipt of bids.
2. References to the National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) are a minimum installation requirement.
3. The following regulatory shall be used as minimum standards:

AEIC	(American Association of Edison Illuminating Companies)
ANSI	(American National Standards Institute)
ASTM	(American Society for Testing and Materials)
ICEA	(Insulated Cable Engineers Association)
IEEE	(Institute of Electrical and Electronic Engineers)
NCCM	(N.C. Construction Manual w/G.S. as listed)
NCSBC	(N.C. State Building Code)
NEC	(National Electrical Code)
NEMA	(National Electrical Manufacturers Association)
NESC	(National Electrical Safety Code)
NFPA	(National Fire Protection Association)
U/L	(Underwriters' Laboratories, Inc.)
OSHA	(Occupational Safety and Health Standards)
ASHRAE/IES	(90.1 energy code)

H. TEST STANDARDS:

1. All material and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., or third party agencies accredited by the North Carolina Building Code Councils latest edition or amendment.

I. PERMITS AND FEES:

2. The Electrical Contractor shall make all necessary arrangements, obtain all necessary approval, obtain all permits and pay fees required for the installation of any of the work covered under the Electrical Work Division of the specifications. Any fees required by any utility companies or municipal authorities for the final connections for these services shall be paid by the Electrical Contractor under whose work such services appear. Before the job is certified as substantially complete, a certificate of approval from all authorities involved must be obtained and turned over to the Architect/Engineer.

J. DRAWINGS AND SPECIFICATIONS:

1. The Electrical Drawings and Specifications are intended to cover all the work enumerated under the respective headings. The drawings are diagrammatic only. No contractor shall take advantage of conflict or error between drawings and specifications, or between general drawings and mechanical, plumbing and/or electrical drawings, but shall request a clarification of such from the Architect/Engineer, should this condition exist. If there is insufficient time to issue an addendum for this clarification, the Electrical Contractor shall include in his bid the most expensive of the items in conflict.

2. The Electrical Contractor shall refer to the architectural and structural drawings and specifications for the general construction of the building, for floors and ceiling heights, for locations of walls, partitions, beams, etc., and shall be guided accordingly for setting of all sleeves, inserts and equipment. No Contractor shall under any circumstances scale drawings for the location of equipment. The Electrical Contractor shall verify the locations of all utility services and electrical equipment.
2. The Electrical Contractor shall keep at least one set of corrected shop and design drawings at the site. Drawings are to be current, denoting approved modifications and actual installed departure. Submit drawings to Architect/Engineer before final payment is made.

K. SUPERVISION:

1. The Electrical Contractor performing the work specified shall be required to employ a qualified superintendent or foreman to continuously supervise the installation of their work, with authorization to act as agent. He shall be capable of checking layouts, coordinating and supervising the work, establishing grades and levels, and locating chases, openings, hangers, inserts, sleeves, etc.

PART II. - PRODUCTS

A. STANDARD PRODUCTS:

1. Unless otherwise indicated in writing by the Architect/Engineer, the materials to be provided under this specification shall be standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest design. All items of the same type or rating shall be identical.

B. SUBMITTAL:

1. The Electrical Contractor shall submit, for approval, detailed shop drawings on all major equipment and where requested. No materials or equipment may be delivered to the job site or installed until the Electrical Contractor has in his possession the approved shop drawing for the particular material or equipment. The Electrical Contractor shall furnish the number of copies required by the General or Special Conditions of the contract, but no case less than six (6) copies.
2. Submitted material shall be properly labeled indicating specific service for which material or equipment to be used, section and article number of specifications governing, Contractor's name, and name of job.
3. Approval of equipment will not relieve the Electrical Contractor of compliance with the specifications even if such approval is made in writing, unless the attention of the Engineer is called to the non-complying features by letter accompanying the submittal data. Approval of submittal data by the Engineer shall not be construed as a complete check of approval of detailed dimensions, weights, gauges, and similar details with the proposed articles. The conformance with the necessary coordination between the various other contractors and suppliers shall be solely the responsibility of the Electrical Contractor and with no additional expense to the owner.

C. SUBSTITUTIONS:

1. Manufacturer's lists are to establish a standard of quality and not intended to limit the selection to these manufacturers. All materials and equipment which are essential and have not been specified or shown shall be new and of the highest grade and quality. Free from

defect or other imperfections. It should be understood that where the words "furnished and installed" are used, it is intended that the Electrical Contractor shall purchase and install all materials required.

D. PRODUCT HANDLING:

1. Equipment and materials shall be properly stored, adequately protected, and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored and protected in accordance with the manufacturer's recommendations and as approved by the Architect/Engineer. Equipment installed with a factory finish shall be fully protected during construction and shall be maintained free of dust, dirt, and foreign matter. Dents and other surface damage shall be repaired or replaced to the satisfaction of the Architect/Engineer at no additional cost to the Owner.
2. The Electrical Contractor shall clean up and remove from the job site all waste materials, packaging, crating, and refuse resulting from his work on a daily basis.

E. MATERIALS AND WORKMANSHIP:

1. The Electrical Contractor shall perform a first class job, both in material and workmanship. None other will be accepted. Deviations from either will be corrected by the Electrical Contractor, at Electrical Contractor's expense.
2. The Material used throughout the work, except when otherwise noted, shall be new and of specification grade and the best of its kind. No substitutes shall be used unless approved by the Architect/Engineer. All work shall be executed with a maximum speed consistent with safety and good workmanship.
3. Any equipment furnished by the Mechanical Contractor or any other contractor that is larger than those indicated on the drawings and described in these specifications or have different electrical characteristics, the increase in cost to the Electrical Contractor for larger wires, conduit, circuit breakers, switches, etc. or for changes in work already installed shall be borne by the instigating contractor.

PART III. - EXECUTION

A. EXCAVATION AND BACKFILL:

1. The Electrical Contractor shall perform any and all trench and pit excavation and backfilling required for the installation of his work. Trenches shall be made with the sides vertical and shall be shored where necessary for the protection of men and equipment. All excavation work shall be done in a careful manner to avoid damage to footers and foundations. The backfilling shall be placed in layers not exceeding 4 inches in depth, wetting each layer as it is placed, and thoroughly compacting each layer with mechanical tamper or other approved means. Any damage done during excavation and backfilling operations to roads, sidewalks, curbs, shrubs, sod, footers, foundations, etc. shall be replaced to its original condition prior to construction, at no expense to the owner. All work will be approved by the Engineer.

B. SCAFFOLDING, RIGGING, AND HOISTING:

1. The Electrical Contractor shall furnish all necessary scaffolding, staging, rigging and hoisting required for the completion of his work. All such scaffolding, etc., shall be removed from the premises when its use is no longer required on the job.

C. CUTTING AND PATCHING:

1. The Electrical Contractor shall provide all cutting and patching necessary to install the work specified in this section. The patching shall match adjacent surfaces.
2. No structural member shall be cut without the approval of the engineer, and all such cutting shall be done in a manner directed by him.
3. Cutting or Holes:
 - a. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Engineer prior to drilling through structural sections.
 - b. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed.

D. WATERPROOFING:

At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified.

E. EQUIPMENT SPACE AND ARRANGEMENT:

1. The equipment shall fit into the space allotted and shall allow adequate clearance for entry, installation, replacement, servicing, and maintenance. The Electrical Contractor shall coordinate the work to ensure that equipment may be moved into place without altering building components or other installations. Access space shall not be less than the equipment manufacturer's requirements. Working clearances shall be not less than N.E.C or other regulatory requirements.
2. These drawings indicate the extent and general arrangement of equipment. If any departures are deemed necessary by the Electrical Contractor, details of such departures and the reasons therefore shall be submitted to the Architect/Engineer for approval as soon as practicable and within 30 days after award of the contract. No departure shall be made without written approval of the Architect/Engineer. Any delay on the Contractors part to provide such submittal will not constitute an extension of the contract time.

F. DAMAGE TO WORK ALREADY IN PLACE:

1. The Electrical Contractor shall assume full responsibility for any damage done by him, his agents or employees, to any work already in place. Any such damage done shall be repaired at the contractor's expense by mechanics skilled at their respective trades, to the approval of the Architect/Engineer.

G. JURISDICTION OF WORK:

1. It may become necessary for the Electrical Contractor to furnish labor or materials which is not generally accepted as part of this trade. In cases of this type, he shall contract the work, or shall furnish materials and employ workmen of the trade involved in order not to cause any delay or stoppage of work caused by infringement of trade agreements as to jurisdiction, alleged or actual.

H. COORDINATION WITH OTHER TRADES:

1. All work shall be coordinated with other trades involved in the construction project. All work shall be carefully laid out in advance to coordinate architectural, structural, mechanical, plumbing and electrical features of construction. The Contractor shall verify at the site all locations, grades, elevations, and utility service connections indicated. Any conflicts due to lack of proper coordination shall be brought to the attention of the Architect/Engineer for resolution. The Electrical Contractor shall make required changes or relocations at no additional cost to the Owner.
2. Installation, inspection, and testing of work above ceilings shall be completed and approved by the Architect/Engineer prior to installation of the specified finished ceilings. However, ceiling suspension system may be installed as required for coordination.
3. The Electrical Contractor shall consult with the other trades at the start of the work and periodically thereafter, as required to properly coordinate the various items of work, and to avoid interferences. Should any interferences of any nature develop as the work progresses, such interferences shall be resolved and eliminated as directed. The cost of any work directed shall be borne by the subcontractor or contractors directed to do this work.

I. DIVISION OF WORK:

1. This paragraph is intended to show exactly the point of division of work between the Electrical Division and the Mechanical Division or any other division.
2. All equipment covered in the Mechanical Division or any other division of the specifications shall be furnished, mounted, and aligned under the respective division. All disconnect switches, starters, conduit, wire for this equipment shall be furnished and installed under the Electrical Division. This includes wiring to the equipment from switches, starters, and disconnects.

Exception: The electrical contractor shall not have to provide starters for packaged mechanical units. Field coordinate with the equipment furnished. If starter is provided by the mechanical equipment supplier the electrical contractor shall be required to provide a disconnect switch at the equipment. Provide disconnect switch as required by N.E.C. Provide loadside wiring from the disconnect switch to the line side connection at the equipment starter.

J. EQUIPMENT INSTALLATION:

1. Manufacturer's Instructions: Equipment shall be installed as recommended by the manufacturer to conform to the requirements of the particular application, in accordance with these drawings and specifications.

K. OPERATION AND MAINTENANCE MANUALS:

1. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:
 - a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

- d. Servicing instructions and lubrication charts and schedules.

L. RECORD DOCUMENTS:

- 1. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - a. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

M. GUARANTEE:

- 1. The Electrical Contractor shall present to the Owner a written guarantee covering his work, including all equipment, material and workmanship. This guarantee shall be against all defects in any of the above work, and shall run for a period of one (1) year from the date of written acceptance of the Contractor's work.
- 2. Any defective work, equipment, material and/or workmanship that develops within the guarantee period, which is not caused by ordinary wear or abuse by other persons, shall be replaced by the Electrical Contractor without cost to the Owner.

N. FINAL INSPECTION:

- 1. When the entire contract has been completed and the work is ready for final inspection, the Architect/Engineer or his duly authorized representative will make the inspection. At the time of inspection, the Electrical Contractor shall demonstrate to the Architect/Engineer that the various systems and pieces of equipment have been adjusted to operate in accordance with the requirements of the contract.

O. FINAL PAYMENTS:

- 1. All final payments are contingent upon all necessary certificates and/or approvals cited above, together with the written guarantee being presented to the Owner.

END OF SECTION 16010

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
 - a. Miscellaneous metals for support of electrical materials and equipment.
 - b. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.

C. DEFINITIONS:

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

D. SUBMITTALS:

1. Product data for the following products:
 - a. Joint sealers.

E. SEQUENCE AND SCHEDULING:

1. Coordinate the new electrical service with the utility company.

PART II. - PRODUCTS

A. SOIL MATERIALS:

1. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
2. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
3. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

B. MISCELLANEOUS METALS:

1. Steel plates, shapes, bars, and bar grating: ASTM A 36.
2. Cold-Formed Steel Tubing: ASTM A 500.
3. Hot-Rolled Steel Tubing: ASTM A 501.
4. Steel Pipe: ASTM A 53, Schedule 40, welded.
5. Fasteners: Zinc-coated, type, grade, and class as required.

C. JOINT SEALERS:

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. Colors: As selected by the Architect from manufacturer's standard colors.
3. Elastomeric Joint Sealers: Provide the following types:
 - a. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - b. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
4. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
5. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.
 - a. Acceptable Products:
 - (1) "Dow Corning Fire Stop Foam," Dow Corning Corp.
 - (2) "Hilti" Fire Stop Systems
 - (3) "Fire Stop Systems, Inc."

PART III. - EXECUTION

A. EXAMINATION:

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. PREPARATION FOR JOINT SEALERS:

1. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

C. EXCAVATION:

1. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
2. Trenching: Excavate trenches for electrical installations as follows:
 - a. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 - b. Excavate trenches to depth indicated or required.
 - c. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
 - d. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
3. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg 2 C).
4. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
 - a. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 - b. Under building slabs, use drainage fill materials.
 - c. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
5. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - b. Removal of trash and debris.
6. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
7. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

8. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
9. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 - a. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - (1) Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - (2) Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - (3) Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - b. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
10. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

D. ERECTION OF METAL SUPPORTS AND ANCHORAGE:

1. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
2. Field Welding: Comply with AWS "Structural Welding Code."

E. APPLICATION OF JOINT SEALERS:

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic- emulsion joint sealants.
2. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

END OF SECTION 16050

SECTION 16100 - RACEWAYS, BOXES, AND CABINETS

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

PART II. - PRODUCTS

A. METAL CONDUIT AND TUBING:

1. Rigid Steel Conduit: ANSI C80.1.
2. Intermediate Metal Conduit: ANSI C80.6.
3. Electrical Metallic Tubing and Fittings: ANSI C80.3 with compression-type fittings.
4. Flexible Metal Conduit: Zinc-coated steel.
5. Liquid tight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.
6. Fittings: NEMA FB 1, compatible with conduit/tubing materials.
7. Nonmetallic Rigid conduit: not allowed.
8. "MC" type cable not acceptable.

B. OUTLET AND DEVICE BOXES:

1. Sheet Metal Boxes: NEMA OS 1.
2. Cast Metal Boxes: NEMA FB 1, type FD, cast alloy box with gasketed cover.

C. PULL AND JUNCTION BOXES:

1. Small Sheet Metal Boxes: NEMA OS 1.
2. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.
3. Pull Boxes: Code gauge steel with screw type removable cover.

PART III. - EXECUTION

A. EXAMINATION:

1. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do

not proceed with installation until unsatisfactory conditions have been corrected.

- B. MINIMUM CONDUIT SIZE: (unless indicated otherwise) on the drawings conduit shall be sized as follows:
1. Indoors: The minimum conduit size shall be 1/2 inch.
 - a. (Exception) 1/2 inch flexible metal conduit may be used for tap connection to recessed lighting fixtures.
 3. Outdoors: Branch circuit conduit installed below grade to exterior equipment shall be 1inch minimum unless noted otherwise.
- C. WIRING METHODS: Unless noted otherwise on the drawings the following materials shall be used:
1. Outdoors: Use the following wiring methods:
 - a. Exposed: Rigid or intermediate metal conduit.
 - b. Concealed: Rigid or intermediate metal conduit.
 - c. Underground, Single Run: Rigid metallic conduit.
 - d. Underground, Grouped: Rigid metallic conduit.
 - e. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquid tight flexible metal conduit.
 - f. Boxes and Enclosures: NEMA Type 3R or Type 4.
 2. Indoors: Use the following wiring methods:
 - a. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit, except in wet or damp locations use liquid tight flexible metal conduit.
 - b. Damp or Wet Locations: Rigid steel conduit.
 - c. Exposed: Electrical metallic tubing above 8 feet and rigid metallic conduit below 8 feet.
 - d. Concealed: Electrical metallic tubing, conduit (where allowed by the N.E.C.).
 - e. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4, stainless steel.
 - f. Below Slab: Rigid Conduit.
- D. INSTALLATION:
1. Telephone/Data/Cable TV outlet boxes shall be 2 gang with appropriate trim and cover. Coordinate cover plates with Owner.
 2. Provide insulated bushings for all conduit ends.

3. Conceal rigid conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and below floors.
4. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
5. Install raceways level and square and at proper elevations. Provide adequate headroom.
6. Complete raceway installation before starting conductor installation.
7. Use temporary closures to prevent foreign matter from entering raceway.
8. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
9. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.
10. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated. Where the number of bends exceed the total number required by the N.E.C. provide pull boxes are required by code.
11. Install raceways parallel to or at right angles to surfaces or structural members, and follow the surface contours as much as practical.
 - a. Run parallel or banked raceways together, on common supports where practical.
 - b. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
12. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - a. Use bonding jumpers where joints cannot be made tight.
 - b. Use insulating bushings to protect conductors.
 - c. Provide expansion joint fittings where required for the raceway used.
13. IMC and GRC shall terminate with either a double locknut/bushing set, or in a threaded hub.
14. Where conduit type "LB" fittings are used all condulets on conduits over 2 inches in size shall be "MOGAL" type.
15. "EMT" connectors shall be compression type only.
16. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.
17. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
18. Install pull cords in all empty raceways. Use monofilament plastic line having not less than 200-lb (90 kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end

of the pull cord.

19. Install raceway sealing fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - a. Where conduits enter or leave hazardous locations.
 - b. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - c. Where otherwise required by the NEC.
20. Stub-Up Connections: Extend conduits through concrete floor a minimum of 6 inches for connection to freestanding equipment. Extend conductors to equipment with flexible metal conduit. Where equipment connections are not made under this Contract verify the length of the flexible connectors.
21. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install separate ground conductor.
22. Provide grounding connections for raceway, boxes, and components. Tighten connectors and terminals according to tightening torques specified in UL Standard 486A.
23. All underground raceways shall be identified by "UNDERGROUND LINE MARKING TAPE" located directly above the raceway at 6 inches below finished grade. Tape shall be permanent, bright-colored, continuous, magnetic strip, printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of the service it is marking. Provide sufficient tape not less than 2/3 of the width of the item marked for the full length of the Raceway.
24. Where underground raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the sub-up out of the slab or earth shall be rigid steel.
25. Pitch ducts to drain towards manholes and handholes and away from buildings and equipment. Minimum slope shall be 4 inches in 100 feet. Where necessary to achieve this between manholes, slope ducts from a high point in the run to drain in both directions.
26. The raceway system shall not be relied on for grounding continuity. See section 16452 for grounding and bonding requirements.

E. PROTECTION:

1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.
 - a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - b. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

F. CLEANING:

1. Upon completion of installation of system, including outlet fittings and devices, inspect

exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 16100

SECTION 16120 - WIRES AND CABLES

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less.

PART II. - PRODUCTS

A. BUILDING WIRES AND CABLES:

1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Applications" Article.
2. Rubber Insulation: Conform to NEMA WC 3.
3. Thermoplastic Insulation: Conform to NEMA WC 5.
4. Cross-Linked Polyethylene Insulation: Conform to NEMA WC 7.
5. Ethylene Propylene Rubber Insulation: Conform to NEMA WC 8.
6. Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG.

B. CONNECTORS AND SPLICES:

1. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with Project's installation requirements and as specified in Part 3 "Applications" Article.

PART III. - EXECUTION

A. EXAMINATION:

1. Examine raceways and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. APPLICATIONS:

1. Feeders: Type RHW/THW, copper conductor, in raceway.
2. Branch Circuits: Type THW, copper conductor, in raceway.
3. Fire Alarm Circuits: Power-limited fire protective signalling circuit cable.

4. Fire Alarm Circuits: Type THHN/THWN, copper conductor, in raceway.

C. INSTALLATION:

1. All conductors shall be copper.
2. Minimum conductor size for power and lighting circuits shall be #12 AWG. Maximum conductor size shall be 500 Kcmil AWG.
3. All power and lighting circuits #10 awg and smaller shall be solid copper conductors. Conductor sizes #8 awg and larger shall be Class "B" stranded copper conductors.
4. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.
 - a. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
 - b. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
5. Conductor Splices: Keep to minimum.
6. Wiring at Outlets: Install with at least 8 inches (300 mm) of slack conductor at each outlet.
7. Connect outlets and components to wiring and to ground as indicated. Tighten to UL Standard 486A.
8. Power and Lighting circuits will be allowed to be grouped where not more than three phase conductors and one common neutral are used, unless noted otherwise.
9. All power circuits noted for computer equipment with isolated grounding shall be individually installed in a separate conduit with separate neutral conductor, grounding conductor, and isolated grounding conductor.
10. In no case shall any wire installed to a device exceed the U.L. rating of the device.

D. SPLICING:

1. Joints in solid conductors shall be using Ideal" wirenuts, "3M Company "scotchlock", or "T&B" "PIGGY" connectors in junction boxes, outlet boxes and lighting fixtures.
2. "Sta-kon" or other permanent type crimp connectors shall not be used for branch circuit connections.
3. Joints in stranded conductors shall be spliced by approved mechanical connectors. Solderless mechanical connectors similar to "NSI" multi-cable connector blocks for splices and taps, provided with UL- approved insulating covers, may be used instead of mechanical connectors plus tape.
4. Conductors in all cases, shall be continuous from outlet to outlet unless "taps" are required and shall be made only within outlet, junction boxes, troughs and gutters.

E. VOLTAGE DROP:

1. Where conductor length from the panel to the first outlet on a 120 volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall be not smaller than #10 awg.

F. FIELD QUALITY CONTROL:

1. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
2. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION 16120

SECTION 16140 - WIRING DEVICES

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes various types of receptacles, connectors, switches, and finish plates.

C. SUBMITTALS:

1. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
2. Product data for each product specified.

PART II. - PRODUCTS

A. WIRING DEVICES:

1. Comply with NEMA Standard WD 1-101968, "General Purpose Wiring Devices."
2. Enclosures: NEMA 1 equivalent, except as otherwise indicated.
3. Color: Ivory except as otherwise indicated or required by Code.
4. Receptacles, Straight-Blade and Locking Type: Comply with UL Standard 498, "Electrical Attachment Plugs and Receptacles," heavy-duty grade 20 amp rated except as otherwise indicated.
5. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicated, and with the following additional requirements:
 - a. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," with integral NEMA 5-20R duplex receptacle. Design units for installation in a 2 and 3/4-inch (70-mm) deep outlet box without an adapter.
6. Single pole and three/four-way toggle type Snap Switches: shall be 20 amp 120/277v. ac., rated, quiet-type a.c. switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches," and with Federal Specification W-S-896. Ivory color.
7. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:
 - a. Material for Finished Spaces: 0.04-inch-thick, type 302, satin-finished stainless steel, standard size except as otherwise indicated.
 - b. Material for Unfinished Spaces: Galvanized cast ferrous steel, standard size.

PART III. - EXECUTION

A. INSTALLATION:

1. Install devices and assemblies plumb and secure.
2. Install wall plates when painting is complete.
3. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
4. Protect devices and assemblies during painting.
5. Field verify the actual location of all outlet devices above equipment or counter tops before rough-in and installation. Any outlet installed in conflict with equipment or conditions which could have been avoided will be corrected at the contractors expense.
 - a. All outlets located above counter tops or back splashes shall be horizontal mounted.
6. Provide weatherproof "PVC" cover plates for all devices exterior to the building or in "wet" locations.

B. IDENTIFICATION:

1. Comply with Division 16 Section "Electrical Identification."
 - a. Switches: Where 3 or more switches are ganged, and elsewhere where indicated, identify each switch with approved legend engraved on wall plate.
 - b. Receptacles: Identify the panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

C. GROUNDING:

1. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.

D. FIELD QUALITY CONTROL:

1. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
2. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.
3. Replace damaged or defective components.

E. CLEANING:

1. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 16140

SECTION 16190 - SUPPORTING DEVICES

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

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

C. SUBMITTALS:

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
2. Product data for each type of product specified.

PART II. - PRODUCTS

A. COATINGS:

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

B. MANUFACTURED SUPPORTING DEVICES:

1. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
2. Fasteners: Types, materials, and construction features as follows:
 - a. Expansion Anchors: Carbon steel wedge or sleeve type.
 - b. Toggle Bolts: All steel springhead type.
 - c. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
3. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
4. U-Channel Systems: 16-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

C. FABRICATED SUPPORTING DEVICES:

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

2. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
3. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
 - (1) 3-inch and smaller: 20-gage.
 - (2) 4-inch to 6-inch: 16-gage.
 - (3) over 6-inch: 14-gage.
 - b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - c. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART III. - EXECUTION

A. INSTALLATION:

1. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
2. Coordinate with the building structural system and with other electrical installation.
3. Raceway Supports: Comply with the NEC and the following requirements:
 - a. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - b. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - c. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - d. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - e. Space supports for raceways types not covered by the above in accordance with NEC.
 - f. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - g. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 - h. In interior spaces provide a minimum of 1/4" space for all conduits installed on the exterior building walls. Approved "clamp-back" or strut devices shall be used.
4. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

5. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
6. Sleeves: Install in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL- listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with the UL requirements.
7. Conduit Seals: Install bushing seals for conduit penetrations of slabs on grade and exterior walls below grade. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
8. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - a. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - b. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - c. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.
9. TESTS: The installation of any type support anchor system used on the project will be tested at the engineers discretion.
10. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION 16190

SECTION 16195 - ELECTRICAL IDENTIFICATION

PART I - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes Identification of Electrical Materials, Equipment and Installations.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.

PART II - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Ideal Industries, Inc.
 - 2. National Band and Tag Co.
 - 3. Panduit Corp.
 - 4. Seton Name Plate Co.
 - 5. Standard Signs, Inc.
 - 6. W.H. Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width. Colors to match color schemes noted herein.
- B. Underground Line Marking Tape: Permanent, bright colored, continuous printed, metallic strip, plastic tape compounded for direct burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl cloth, self adhesive, wrap-around, cable/conductor markers with pre-printed numbers and letter.
- D. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16th inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8th inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners. (Match face colors with the system equipment.) See color schemes.
- E. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- F. Cable Ties: Fungus inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when

used for color coding.

PART III - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors and other designations used in Electrical Identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- C. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be colored adhesive marking tape, (painting of conduit will not be allowed). Make each color band 3 inches wide, completely encircling conduit. Install bands at changes in direction, at penetrations of walls and floors, and at 25-foot maximum intervals in straight runs. Apply the following colors:
 - 1. Data/Voice System: Yellow
 - 2. Telephone System: Green
- D. Identify Junction, Pull, and Connection Boxes: Install on outside of box cover. Label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels concealed boxes. Color code boxes as indicated in (3) above. Method shall be by colored adhesive not less than 4 square inches for 4" boxes and larger boxes. Permanent type "magic" markers are not accepted as a means of identification.
- E. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal and communications lines, install continuous underground plastic line marker, located directly above line at 6 inches below finished grade where multiple lines are installed in a common trench or concrete envelope. Provide marker tape to cover 2/3 of the overall width.
- F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<u>208/120 Volts</u>	<u>Phase</u>
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground

- G. Use conductors with color factory-applied the entire length of the conductors except as follows:
 - 1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be

adjusted slightly to prevent such obliteration minimum width 2".

- H. Tag or label conductors as follows:
 - 1. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 - 2. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- I. Install equipment/system circuit/device identification as follows:
 - 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1.2 inch high lettering on 1½ inch high label (2 inch high where two lines are required), white lettering in black field for normal power equipment other face colors shall match the equipment served. Text shall match terminology and numbering of the Contract Documents and shop drawings.
 - 2. All Phenolic labels shall be securely attached to the equipment by self-tapping stainless steel screws.
 - 3. Name plate colors shall be as follows:
 -Blue surface with white core for 120/208 Volt Equipment.
- J. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker. Pencil in all spare and leave spaces blank.
- K. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- L. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by pressure sensitive label applied to the conduit or outlet; designate "use" and "location served".

END OF SECTION 16195

SECTION 16420 - SERVICE ENTRANCE

PART I - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SUMMARY

- A. Extent of Service Entrance work is indicated by Drawings and Schedules.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on Service Entrance equipment and accessories.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of service entrance equipment, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience with projects utilizing Service Entrance work similar to that required for this project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC, including Articles 230, 250, and 338, as applicable to installation and construction of Service Entrances.
 - 2. NEMA Compliance: Comply with applicable Construction and Installation Requirements of the following NEMA standards for Service Entrance Equipment and Accessories:
 - a. Stds. Pub/No. AB 1: Molded-Case Circuit Breakers.
 - b. Stds. Pub/No. AB 3: Molded-Case Circuit Breakers and their application.
 - c. Stds. Pub/No. PB 2: Dead-Front Distribution Switchboards.
 - d. UL Compliance: Comply with construction and installation requirements of the following UL standards for Service Entrance Equipment and Accessories:
 - e. UL 50: Electrical Cabinets and Boxes.
 - 3. UL 489: Molded Case Circuit Breakers and Circuit Breaker Enclosures.
 - a. UL 869: Electrical Service Equipment.
 - 4. Provide Service Entrance Equipment and Accessories which are UL-listed and labeled and marked, "SUITABLE FOR USE AS SERVICE EQUIPMENT".

5. IEEE Compliance: Comply with applicable requirements of IEEE Std 241 pertaining to Service Entrances.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver Service Entrance equipment components properly packaged and mounted on pallets or skids to facilitate handling of heavy items.
- B. Store Service Entrance equipment in original packaging indoors until installation.
- C. Handle Service Entrance equipment carefully. Do not install damaged equipment; remove from site and replace with new equipment.

1.6 SEQUENCING AND SCHEDULING

- A. Schedule delivery of Service Entrance equipment that permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.
- B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- C. Coordinate with other electrical work including raceways, electrical boxes and fittings and cabling/wiring work, as necessary to interface installation of Service Entrance work with other work.
- D. Coordinate the available fault current at each point of Service Entrance device. Modify breaker as required from the minimum shown on the Plan and Schedules.

PART II - PRODUCTS

2.1 SERVICE ENTRANCE EQUIPMENT

- A. General: Provide Service Entrance Equipment and Accessories of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published product information and as required for complete installation and as herein specified.
- B. Circuit Breakers: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings, and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
 1. Molded-Case Circuit Breakers: Provide factory-assembled, molded-case circuit breaker of frame sizes indicated; see the main distribution panel schedule on the drawings for ratings and sizes of breakers required. Circuit breakers shall be rated not less than the minimum available at the secondary of the service transformer. Coordinate with the utility company. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole. Construct with over-center, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated and with NEMA Type 1 general purpose enclosures.

Note: The Contractor shall coordinate with the utility company as to the fault current available at the service point and notify the Engineer, so that the

breaker rating can be adjusted accordingly.

PART III - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which Service Entrance equipment and components are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT

- A. Install Service Entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices to ensure that Service Entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA Standards.
- B. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A and B and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of Service Entrance equipment, check accessible connections for compliance to manufacturer's Torque Tightening Specifications.
- B. Prior to energization of Service Entrance equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check circuitry for electrical continuity and for short circuits.

3.4 GROUNDING

- A. Provide equipment grounding connections for Service Entrance equipment as indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding.

3.5 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred enclosure surfaces to match original finishes.

3.6 DEMONSTRATION

- A. Upon completion of installation of Service Entrance equipment and electrical circuitry, energized circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units and re-test to demonstrate compliance.

END OF SECTION 16420

SECTION 16452 - GROUNDING

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

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

C. QUALITY ASSURANCE:

1. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

PART II. - PRODUCTS

A. GROUNDING AND BONDING PRODUCTS:

1. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
2. Conductor Materials: Copper.

B. WIRE AND CABLE CONDUCTORS:

1. General: Comply with Division 16 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
2. Equipment Grounding Conductor: Green insulated.
3. Grounding Electrode Conductor: Stranded cable.
4. Bare Copper Conductors: Conform to the following:
 - a. Solid Conductors: ASTM B-3.
 - b. Assembly of Stranded Conductors: ASTM B-8.
 - c. Tinned Conductors: ASTM B-33.

C. MISCELLANEOUS CONDUCTORS:

1. Ground Bus: Bare annealed copper bars of rectangular cross section, full-size rated.
2. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.
3. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except

as indicated.

D. CONNECTOR PRODUCTS:

1. General: Listed and labeled as grounding connectors for the materials used.
2. Pressure Connectors: High-conductivity-plated units.
3. Bolted Clamps: Heavy-duty units listed for the application.
4. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

E. GROUNDING ELECTRODES:

1. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
 - a. Size: 3/4 inch by 10 feet.

PART III. - EXECUTION

A. APPLICATION:

1. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
 - a. Install an equipment ground conductor in all power related conduits. Size conductor as required by NEC, Data and Signal conduits do not require a separate grounding conductor unless required by the manufacturer of the equipment to be installed.
2. Underground Conductors: Bare, stranded copper except as otherwise indicated.
3. Signal and Communications: For telephone, alarm, and communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal equipment location. Leave 3' pigtail wiring at termination point where equipment boards are shown. Make direct connection where equipment is provided.
4. Separately derived systems required by NEC to be grounded shall be grounded in accordance with NEC paragraph 250-26.

B. INSTALLATION:

1. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
2. The electrical service shall be grounded by three (3) means:
 - a. To the cold water main, if metallic and in direct contact with the earth for at least 10 feet as per the NEC Article 250-81.
 - b. To the steel frame of the building, provided the building frame is effectively grounded.
 - c. To ground rod(s).
3. Ground Rods: Locate a minimum of one-rod length from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors

buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use 3/4-inch by 10-ft. ground rods except as otherwise indicated. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated. All ground connections shall be accessible.

4. **Metallic Water Service Pipe:** Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Bond the ground conductor conduit to the conductor at each end.
5. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

C. CONNECTIONS:

1. **General:** Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 - b. Make connections with clean bare metal at points of contact.
 - c. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps.
 - d. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
2. **Exothermic Welded Connections:** Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
3. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
4. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
5. **Compression-Type Connections:** Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground

conductor.

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

D. FIELD QUALITY CONTROL:

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

After completion of the electrical grounding and bonding systems, test the ground resistance with a ground resistance tester. Where test shown resistance-to-ground is over 25 ohms, provide additional ground rods until the minimum of 25 ohms is achieved.
3. Ground/resistance maximum values shall be as follows:
 - a. Equipment rated 500 kVA and less: 10 Ohms
 - b. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
4. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.
5. Report: Prepare test reports of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. CLEANING AND ADJUSTING:

1. Restore surface features at areas disturbed by excavation and reestablish original grades. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

END OF SECTION 16452

SECTION 16470 - PANELBOARDS

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

C. DEFINITIONS:

1. Panelboards: A panelboard with thermal magnetic circuit-breaker branches, designed for light commercial projects, operating at 600 V and below, available in both single and 3-phase versions, and equipped with combination flush/surface mounting trim.
2. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

D. SUBMITTALS:

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
2. Product data for each type panelboard, accessory item, and component specified.
3. Shop drawings from manufacturers of panelboards including dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
 - a. Enclosure type with details for types other than NEMA Type 1.
 - b. Bus configuration and current ratings.
 - c. Short-circuit current rating of panelboard.
 - d. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

E. QUALITY ASSURANCE:

1. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - a. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
2. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."
3. NEMA Standard: Comply with NEMA PB1, "Panelboards."
4. UL Standards: Comply with UL 61, "Panelboards," and UL 50, "Cabinets and Boxes."

PART II. - PRODUCTS

A. MANUFACTURERS:

1. Acceptable Manufacturers:
 - a. Crouse-Hinds Distribution Equipment.
 - b. General Electric Co.
 - c. Siemens.
 - d. Square D Co.

B. PANELBOARDS, GENERAL REQUIREMENTS:

1. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated on the schedules. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.
2. Circuit Breakers shall be plug-in type unless otherwise required.
3. 100% rated copper Ground and Neutral Bus (unless noted otherwise).
4. Enclosures: Cabinets, flush or surface mounted as indicated. NEMA Type 1 enclosure.
5. Front: Secured to box with concealed trim clamps except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box except as otherwise specified.
6. Directory Frame: Metal, mounted inside each panel door.
7. Bus: Hard drawn copper of 98 percent conductivity.
8. Main and Neutral Lugs: Bolt-on type.
9. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
10. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.
11. Special Features: Provide the following features for panelboards as indicated.
 - a. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 - b. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover. (Panel "WB" only).
12. Main Service Panel shall be rated "SUITABLE FOR SERVICE ENTRANCE".

C. IDENTIFICATION:

1. Panelboard Nameplates: Engraved laminated plastic or metal nameplate for each panelboard mounted with self tapping stainless steel screws.

PART III. - EXECUTION

A. INSTALLATION:

1. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.
2. Mounting Heights: Top of trim 6 feet-2 inches above finished floor, except as indicated.
3. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.
4. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing. Pencil all spares. Spaces shall be left blank.
5. Install filler plates in unused spaces.
6. Wiring in Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

B. GROUNDING

1. Connections: Make equipment grounding connections for panelboards as indicated.
2. Provide ground continuity to main electrical ground bus indicated.

C. CONNECTIONS:

1. All connections shall be provided per UL 486A and UL 486B.

D. FIELD QUALITY CONTROL:

1. Quality Control Program: Conform to the following:
 - a. Procedures: Field tests and inspections will be made by the engineer at time of completion of the work and in accordance these specifications.
 - b. Schedule tests with at least one week in advance notification.
2. Visual and Mechanical Inspection: Include the following inspections and related work:
 - a. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 - b. Exercise and perform of operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - c. Check panelboard mounting, area clearances, and alignment and fit of components.
 - d. Check tightness of bolted electrical connections with calibrated torque wrench.

E. CLEANING:

1. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 16470

SECTION 16515 - INTERIOR LIGHTING

PART I - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes interior lighting fixtures, lamps, ballasts, emergency lighting units, and accessories.

C. SUBMITTALS:

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
2. Product data describing fixtures, lamps, ballasts, and emergency lighting units. Arrange product data for fixtures in order of fixture designation. Include data on features and accessories and the following information:
 - a. Outline drawings of fixtures indicating dimensions and principal features.
 - b. Electrical ratings and photometric data with specified lamps and certified results of independent laboratory tests.
 - c. Data on batteries and chargers of emergency lighting units.
3. Shop drawings from manufactures detailing nonstandard fixtures and indicating dimensions, weights, methods of field assembly, components, features, and accessories.
4. Non-returnable samples, when requested by Engineer, for verification purposes of specific individual fixtures.

D. QUALITY ASSURANCE:

1. Comply with NFPA 70 "National Electrical Code" for components and installation.
2. Listing and Labeling: Provide fixtures that are listed and labeled for their indicated use on the Project.
3. Coordination of Fixtures With Ceiling: Coordinate fixtures mounting hardware and trim with the ceiling system. Provide plaster or sheetrock trims when required on the project whether indicated or not at no additional cost to the owner. Coordinate with architectural plans before ordering fixtures.

E. WARRANTY:

1. Minimum warranty period on emergency lights shall be 3 years from date acceptance. Warranty shall include all parts (less lamps).
2. All other lighting products shall be warranted for a period of not less than 1 year from date of acceptance. This warranty does not include miscellaneous parts which are external to the product (i.e lamps) which are considered maintenance item.

PART II - PRODUCTS

A. FIXTURES, GENERAL:

1. Comply with the requirements specified the lighting fixture schedule on the drawings.
1. Fixtures: Conform to UL 1570, "Fluorescent Lighting Fixtures."
2. Ballasts: Conform to UL 935, "Fluorescent-Lamp Ballasts"
 - a. Certification: By Electrical Testing Laboratory (ETL).
 - b. Labeling: By Certified Ballast Manufacturers Association (CBM).
 - c. Type: Class P, high-power-factor energy saving type except as indicated otherwise.
 - d. Sound Rating: A rating, except as indicated otherwise.
 - e. Voltage: Match connected circuits.

PART III - EXECUTION

A. INSTALLATION:

1. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop drawings.
2. Support For Recessed and Semirecessed Fixtures: Units shall be supported independent from suspended ceiling. Install fixture with support wires at all four corners to the structure or building steel.
 - a. Fixtures of Sizes Less Than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees.
 - b. Install support clips or screws for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corners.
 - c. Support wires shall be not less than the support wires for the ceiling system.
3. Support for Suspended Fixtures: Brace pendants and rods that are 4-feet long or longer to limit swinging. Support stem mounted single-unit suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
4. Lamping: See schedule on drawings, or provide standard lamp for the rating of the fixture.
5. Where mounting height for fixtures are not scheduled, coordinate with the engineer before any installation.

B. FIELD QUALITY CONTROL:

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Emergency battery units test: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical energy for a period of not less than 90 minutes to demonstrate proper operation of emergency lighting installation. Include the following in tests of emergency lighting equipment.
 - a. Duration of supply.
 - b. Low battery voltage shut-down.
 - c. Normal transfer to battery source and retransfer to normal.

- d. Low supply voltage transfer.
 - 3. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
- C. ADJUSTING AND CLEANING:
- 1. Clean fixtures upon completion of installation. Use methods and materials recommended by manufacturer.
 - 2. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 16515

SECTION 16476 - DISCONNECTS

PART I. - GENERAL

A. RELATED DOCUMENTS:

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

B. SUMMARY:

1. This Section includes Equipment and Service disconnects.

C. SUBMITTALS:

1. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
2. Product data for switches and accessories specified in this Section.

D. QUALITY ASSURANCE:

1. Comply with NFPA 70 "National Electrical Code" for components and installation.
2. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - a. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

PART II. - PRODUCTS

A. MANUFACTURERS:

1. Acceptable Manufacturers:
 - a. Crouse-Hinds Distribution Equipment.
 - b. Cutler-Hammer Products; Eaton Corp.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.

B. ENCLOSED SWITCHES:

1. Enclosed Nonfusible Switch: NEMA KS 1, Type HD, handle lockable with 2 padlocks.
2. Enclosed Fusible Switch, 800 Amperes and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
3. Enclosure: NEMA KS 1, Type 1, unless specified or required otherwise to meet environmental conditions of installed location.
 - a. Outdoor Locations: Type 3R.
 - b. Other Wet or Damp Indoor Locations: Type 4.
4. All switches shall be "Heavy Duty" rated for the voltage required.
5. Coordinate all fuse rated switches with the equipment to be furnished.

PART III. - EXECUTION

A. INSTALLATION:

1. Install enclosed switches in locations as indicated, according to manufacturer's written instructions.
2. Install enclosed switches level and plumb.
3. Where fuses are required, the fuses shall be matched with the equipment supplier's requirements.

B. FIELD QUALITY CONTROL:

1. Testing: After installing enclosed switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.5 for enclosed switches.
2. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

C. CLEANING:

1. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 16476