

SECTION 16000

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, materials, tools, supplies, equipment, and temporary utilities to complete the work shown on the Drawings and specified herein for the illumination upgrade. All systems are to be completely installed and fully operational. Specifically, the work includes, but is not limited to:
 - 1. Electric services, secondary feeders, branch circuits, contactors, all connections to controls, and equipment
 - 2. Installation of underground conduits and splices
 - 3. Complete lighting systems
 - 4. Complete grounding system including system and equipment

1.02 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General Conditions and Special Conditions, apply to all the work specified herein.

1.03 LAWS, PERMITS, FEES AND NOTICES

- A. Secure and pay all permits, fees, and licenses necessary for the proper execution and completion of the work. Submit all notices and comply with all laws, ordinances, rules and regulations of any public agency bearing on the work. Contractor shall be a licensed electrical contractor in the county of construction.

1.04 DEPARTURES

- A. If any departures from the Contract Drawings of Specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practicable to the ENGINEER for advance written approval.

1.05 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Drawings and Specifications, the wiring for such equipment shall be changed to proper sizes to match at no additional expense to the OWNER.

1.06 AS-BUILT INFORMATION

- A. A set of "red-lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis, so the drawings will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER.

1.07 EXCAVATING FOR ELECTRICAL WORK

- A. General – Excavation or drilling, backfill and repair of paving and grassing shall be in the bid of the electrical contractor. The actual work need not be performed by electrical trades. However, the electrical contractor is responsible for all excavation, drilling, dewatering, backfilling, tamping, and repair of pavements and grassing required in support of electrical work. All areas disturbed by electrical work shall be repaired to their original condition, or as indicated on the drawings.
- B. Coordination
 - 1. The electrical contractor must check for existing utilities before commencing any excavation or drilling.
 - 2. Contract drawings and other trades are to be consulted to avoid interferences with other utilities on this project.
 - 3. In the event of damage to existing utilities, the OWNER and ENGINEER shall be immediately notified, and damage shall be immediately repaired.
- C. Precautions – The electrical contractor must take every reasonable precaution to avoid interferences. In the vicinity of a suspected interference, excavations shall be dug by hand.

1.08 JOB SITE VISIT

- A. Visit the project site before submitting a bid. Verify all dimensions shown on the Contract Drawings and determine the characteristics of existing facilities which will affect performance of the work, but which are not shown on the Drawings or described within these Specifications.

1.09 CODES AND STANDARDS

- A. Applicable provisions of the following codes and standards, and other codes and standards required by the State of Florida and local jurisdictions, are hereby imposed on a general basis for electrical work (in addition to specific applications specified by individual work sections of these specifications).
 - 1. U.L. – Electrical materials shall be approved by the Underwriters' Laboratories, Inc. This applies to materials which are covered by U.L. standards.
 - 2. NEC – National Electrical Code (NFPA-70-2014)
 - 3. OSHA – Standards of the Occupational Safety and Health Administration are to be complied with.
 - 4. NEMA – National Electrical Manufacturers Association Standards are to be met wherever standards have been established by that agency, and proof is specifically required with material submittals for switchboards, motor control centers, panelboards, cable trays, motors, switches, circuit breakers, and fuses.
 - 5. ANSI – American National Standards Institute
 - 6. Florida Building Code (2017 6th Edition)

1.10 ELECTRICAL SUBMITTALS

- A. The CONTRACTOR shall submit shop drawings, samples and certificates in accordance with the Special Conditions for additional instructions on substitutions. Submittals will not be accepted for partial systems. Submit all materials for each specifications section at one time. Submittals must be arranged, correlated, indexed and bound in orderly sets for ease of review.
- B. Shop drawings and manufacturer's data sheets are required for all electrical materials. Samples are to be supplied for any substitute as requested by the ENGINEER.
- C. Submit Shop Drawings, manufacturer's data, and certifications on all items of electrical work prior to the time such equipment and materials are to be ordered. Order no equipment or materials without approval from the ENGINEER.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. The CONTRACTOR shall submit Operation and Maintenance (O&M) Manuals in accordance with Division 1, General Requirements. O&M Manuals must contain, but are not limited to, the following:
 - 1. Brief description of system and basic features
 - 2. Manufacturer's name and model numbers of all components of the system
 - 3. List of local factory authorized service companies
 - 4. Operating instructions, including preparation for starting up, seasonal changes, shut down and service
 - 5. Maintenance instruction
 - 6. Possible breakdowns and repairs
 - 7. Manufacturer's literature describing each piece of equipment
 - 8. Control diagrams by the control manufacturer
 - 9. Description of sequence by the control manufacturer
 - 10. Parts list
 - 11. Wiring diagrams

1.12 SPARE PARTS

- A. Submit in accordance with Division 1, General Requirements, a list of Recommended Spare Parts for all major items of equipment. Include descriptions of each part, part number, and cost.

1.13 PROJECT DOCUMENTS

- A. For "As Built" drawing requirements, see Division 1.
- B. In addition, each "As Built" single line diagram shall be framed under glass and mounted on wall near respective contactors and controls.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Electrical Temporary Facilities – The CONTRACTOR shall include in his bid the cost of furnishing, installing and maintaining all materials and equipment required to provide temporary light and power to perform the work of all trades during construction and until work is completed. Adequate lighting and receptacle outlets for operation of hand tools shall be provided throughout the project, including shanties, trailers, field offices, temporary toilet enclosures, and shall be extended as construction progresses.
- B. All reasonable safety requirements shall be observed to protect workers and the public from shock and fire hazards.
 - 1. Ground fault interrupters shall be employed in accordance with Codes.
 - 2. Ground wires are required in all circuits. Ground poles are required on all outlets. All metallic cases shall be grounded.
 - 3. Rain-tight cabinets shall be used for all equipment employed in wet areas.

2.02 ELECTRICAL PRODUCTS

- A. Unless otherwise indicated in writing by the ENGINEER, the products to be furnished under this specification shall be the manufacturer's latest design. Where two or more units of the same class of equipment are required, these units shall be products of the same purpose and rating shall be interchangeable throughout the project.
- B. All products shall be newly manufactured. Defective equipment or equipment damaged in the course of the installation or a test shall be replaced or repaired in a manner meeting the approval of the ENGINEER, at no additional expense to the OWNER.

2.03 SUBSTITUTIONS

- A. Comply with instruction in the Contract General Conditions and Special Conditions regarding substitutions.

2.04 ELECTRICAL IDENTIFICATION

- A. Color Coding – Conductor colors shall be in accordance with NEC and NEMA requirements. Refer also to applicable sections of these specifications. Three-phase feeder and branch circuits shall be identified as follows:

120/240	277 / 480
A – Black	A – Brown
B – Red	B – Orange
C – Blue	C – Yellow
N - White	N – Gray

Green or bare for grounding conductors
Green with Yellow trace for Special Grounding

2.05 NAMEPLATE

- A. The following items shall be equipped with nameplates – All motors, motor starters, motor control centers, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches, high voltage boxes, and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- B. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277 / 480 V, 3-phase, 4-wire." The name of the machine on the motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at pushbutton stations, thermal overload switches, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the drawings. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium-plated, steel self-tapping screws or nickel-plated brass bolts. Motor nameplates may be nonferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with shop drawing submittal for ENGINEER's approval.
- C. All junction and splice boxes shall be labeled using permanent shipping tags attached to boxes, not covers.

2.06 WIRE AND CABLE IDENTIFICATION

- A. All wire and cable shall be identified at each termination point and at each pull box, splice box, junction box, or manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage. Comply with OWNER's instruction for storage locations.

3.02 ELECTRICAL COORDINATION

- A. The CONTRACTOR is responsible for coordination with the OWNER, ENGINEER, the power company, and the telephone company on all matters that have a bearing on the electrical work.

- B. The Drawings indicate the extent, the general location, and arrangement of equipment, conduit, and wiring. Study the Drawings, including details, so the equipment shall be properly located and readily accessible. Locate all electrical equipment to avoid interference with mechanical and / or structural features. Make necessary changes in spacings and locations of lighting fixtures, panelboards, cabinets, receptacles and other items of equipment provided that the overall patterns of layouts are not disrupted and remain uniform.

3.03 CUTTING AND PATCHING

- A. Cut and prepare all openings, chases, and trenches required for the installation of equipment and materials. Repair, remodel, and refinish in strict conformance with the quality of workmanship and materials in the surroundings. Obtain written permission from the ENGINEER for any alterations to structural members before proceeding. All penetrations through fire walls or floor / ceiling slabs shall be sealed to maintain the fire integrity of the wall or slab.

3.04 MAINTENANCE

- A. Render all necessary measures to insure complete protection and maintenance of all systems, materials, and equipment prior to final acceptance. Any materials or equipment not properly maintained or protected to assure a "factory new" condition at the time of final acceptance shall be replaced immediately at no additional cost to the OWNER.

3.05 WATERPROOFING

- A. Whenever any work penetrates any waterproof area, seal and render the work waterproof. All work shall be accomplished so as not to void or diminish any waterproofing bond or guarantee.

3.06 TESTS

- A. Conduct an operating test of equipment prior to the ENGINEER's approval. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications. The tests shall be performed in the presence of the ENGINEER or an authorized representative. The CONTRACTOR shall furnish all instruments, electricity and personnel required for the tests.

3.07 CLEANUP

- A. Maintain continuous cleanup during the progress of the work, and use appointed storage areas for supplies. The premises shall be kept free from accumulations of waste materials and rubbish.

END OF SECTION

SECTION 16011

CODES & STANDARDS

PART 1 - GENERAL

1.01 THIS SECTION COVERS THE CODES, SPECIFICATIONS AND STANDARDS CONSIDERED MINIMUM REQUIREMENTS FOR MATERIALS, WORKMANSHIP AND SAFETY FOR ALL DIVISIONS 16 AND RELATED ELECTRICAL WORK.

1.02 SPECIFICATIONS, CODES AND STANDARDS

- A. Reference within this Specification to standards, codes or reference specifications implies that any item, product or material so identified must comply with all minimum requirements as stated therein, except packaging and shipping, unless indicated otherwise. Only the latest revised editions are applicable.

Some of the references used in this Division are as follows:

NFPA	National Fire Protective Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
U.L.	Underwriters' Laboratories, Inc.
ANSI	American National Standards Institute
FS	Federal Specification
FBC	Florida Building Code

- B. The Specifications, codes and standards indicated below and in other Sections, including the current addenda, amendments and errata, referred to by basic designation only, form a part of this specification.

NFPA-70	National Electrical Code (2014)
NFPA-90A	Air Conditioning & Ventilation (Current Edition)
NFPA-101	Code for Safety to Life (Current Edition)
F.B.C.	Florida Building Code (6 th Edition)

1.03 UNDERWRITERS' LABORATORIES

- A. Where materials and equipment are available under the continuing inspection and labeling service of U.L.; provide such material and equipment.
- B. Listing by Underwriters' Laboratories shall be evidenced by the label or:
U.L. - Electrical Construction Materials List (Green Book)
U.L. - Electrical Appliance & Utilization Equipment List
U.L. - Building Materials List

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide all material as required for a complete project as required by the Drawings and in this Specification.

1.02 SHOP DRAWING SUBMITTALS

- A. Submit shop drawings for the following:
 - All raceways
 - Switchgear
 - Wiring and Splices
 - Contactors, Relays, Photocells
 - Poles and Fixtures

PART 2 - PRODUCTS

2.01 RACEWAY

- A. Galvanized Rigid Conduit (ANSI C80.0) – Rigid galvanized steel conduit "RGS" shall be U.L. Approved, Schedule 40, mild steel pipe, zinc-coated on the inside and outside. Fittings shall be zinc-coated, U.L. Approved.
- B. PVC Conduit – Underground PVC conduit shall be Schedule 40 or Schedule 80 unless otherwise noted, and shall be U.L. approved. PVC conduit shall be Schedule 80 when installed above ground.
- C. Locations: – Conduit shall be used as follows:
 - 1. All above ground grade exposed conduits shall be hot dipped galvanized rigid steel except otherwise noted on the Drawings.
 - 2. All conduits penetrating rated fire walls or rated fire floors shall be installed with U.L. Approved devices to maintain the fire rating of the wall or floor penetrated.

2.02 WIRE AND CONNECTORS

- A. Cable shall be rated for 600 volts and shall meet the requirements below:
 - 1. Conductors shall be stranded.
 - 2. All wire shall be brought to the job in unbroken packages and shall bear the date of manufacturing; not older than 12 months.
 - 3. Type of wire shall be THWN or THHN rated 75 degrees C, suitable for wet locations except where otherwise required by the drawings.

4. No wire smaller than No. 12 AWG shall be used unless specifically indicated.
5. Conductor metal shall be copper.
6. All conductors shall be meggered after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

2.03 BOXES

- A. Boxes for wiring devices (switches and receptacles) installed outdoors or wet locations shall be weatherproof fiberglass with polycarbonate cover plates. Junction boxes shall be NEMA 4X construction, unless otherwise noted. All boxes shall be securely mounted, plumb and level, in readily accessible locations.
- B. Pull boxes in ground shall be Pencil HHPL 172012 with green lid marked "ELECTRIC".

2.04 GROUNDING

- A. Grounding and Bonding – All Grounding and Bonding shall be in accordance with NFPA 70. Ground all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in raceways, and neutral conductor of wiring systems.
- B. Grounding Conductor – Provide an insulated, green-colored equipment grounding conductor in all feeder and branch circuits. This conductor shall be separate from the electrical system neutral conductor. Conduits will not be approved as grounding conductor.
- C. The CONTRACTOR shall install all ground rods, ground wires, and connectors as required for the complete grounding system.
- D. All metal parts and grounding conductors in each manhole or pullbox shall be grounded to a local ground rod.
- E. Resistance – Readings shall not be taken within 48 hours of a rainfall.
- F. The CONTRACTOR shall provide a written report for all grounding test results to the ENGINEER. The test shall include all ground connections. The report shall be signed by the OWNER of the contracting firm and shall include: test date, time, weather conditions on test date, weather conditions 3 days prior to the test date, location, and results.
- G. All raceways require grounding conductors; metallic raceways are not adequate grounding paths. Bonding conductors through the raceway systems shall be continuous from main switch ground buses to panel ground bars of panelboards, and from panel grounding bars of panelboards, and motor control centers to branch circuit outlets, motors, lights, etc. These ground conductors are required throughout the project regardless of whether conduit runs or the Cable and Conduit Schedule show ground conductors on the Drawings.

- H. All connections made below grade shall be of the exothermic type.

PART 3 - EXECUTION

3.01 CONDUIT INSTALLATION

A. General

1. Nylon pull cords shall be installed in all empty conduits. Wire shall not be installed until all work of any nature that may cause damage is completed, including pouring of concrete. Mechanical means shall not be used in pulling in wires 8 AWG or smaller.
2. The use of running threads is prohibited and where some such device is necessary, split couplings, Erickson couplings, or equal shall be used. Where water-tight conduit installations are required, water-tight conduit unions shall be used.
3. All conduits shall be cleaned by pulling a brush swab through before installing cables.
4. All conduits shall be sealed at each end with electrical putty or Duct Seal. Special care shall be taken at all equipment where entrance of moisture could be detrimental to equipment.

B. Handling

1. Conduits subjected to rough handling or usage shall be removed from the premises.
2. Conduits must be kept dry and free of water or debris with approved pipe plugs or caps. Care shall be given that plugs or caps are installed before pouring of concrete. All spare conduits shall remain plugged or capped upon project completion.

C. Concrete and Masonry

1. Where conduits pass through exterior concrete walls or fittings below grade, the entrances shall be made watertight. This shall be done by providing pipe sleeves in the concrete with 1/2" minimum clearance around the conduits, and caulking with askum and sealant, or by means of conduit entrance seals.
2. Where embedded conduits cross expansion joints, furnish and install offset expansion joints or sliding expansion joints. Sliding expansion joints shall be made with straps and clamps.

D. Panelboards and Boxes

1. Conduits entering panelboards, pull boxes, or outlet boxes shall be secured in place by galvanized locknuts and bushings, one locknut outside and one locknut inside of box with bushing on conduit end. The locknuts shall be tightened against the box without deforming the box. Bushings shall be of the insulating type.

- E. Bending
 - 1. Field conduit bends shall be made with standard tools and equipment manufactured especially for conduit bending.
- F. Mounting and Concealing
 - 1. Conduit runs shall always be concealed in finished spaces and may be exposed in industrial spaces except where indicated on the Drawings.
 - 2. Exposed runs of conduits shall be installed with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of symmetrical bends or pull boxes as indicated on the Drawings. Bends and offsets shall be avoided where possible.
 - 3. Where conduits are run individually, they shall be supported by approved pipe straps, secured by means of: 1) toggle bolts or hollow masonry; 2) expansion shields and machine screws or standard preset inserts on concrete or solid masonry; 3) machine screws or bolts on metal surfaces, and wood screws on wood construction. The use of perforated straps or wires will not be permitted.
 - 4. Concrete inserts and pipe straps installed shall be stainless steel unless otherwise noted on the Drawings. All bolts, nuts, washers, and screws shall be stainless steel. Individual hangers, trapeze hanger, and rods shall be prime-coated and painted. Conduit support clamps shall be the two-piece type.
 - 5. Conduit support struts, clamps, bolts, nuts and washers installed outdoors and in corrosive atmosphere indoors or on floors shall be stainless steel.
 - 6. In furred ceilings, conduit runs shall be supported from structure, not furring.

3.02 TERMINATIONS AND SPLICES

- A. Terminations of power cable shall be by means of U.L. approved connectors. All connectors shall meet U.L. 486B and shall be compatible with the conductor material.
- B. Splicing of power, control, or instrumentation wiring will not be allowed except by written approval of the ENGINEER. Where splicing is allowed, splices shall be made waterproof regardless of location.

3.03 GROUNDING

- A. General – Grounding shall be as indicated, and as required by NFPA 70 and ANSI-C2.
- B. Grounding Connections – Grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required, shall be made by exothermic weld. Exothermic welds shall be made strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces,

indicating improper cleaning, are not acceptable. No mechanical connector is required at exothermic weldments.

- C. Grounding Grid System – Conductors shall be buried a minimum of 24 inches in the ground. All cable crossings shall be securely bonded and the system connected to the ground system as well as to all equipment and structural steel work, and to all water piping.
- D. Grounding Conductors – Conductors shall be insulated copper wire and sized as required by National Electrical Code.

3.04 FIELD TESTS

- A. As an exception to requirements that may be stated elsewhere in the Contract, the ENGINEER shall be given five working days notice prior to each test. The CONTRACTOR shall demonstrate that all circuits and devices are in good operating conditions.
- B. Test on 600 Volts wiring – Verify all 600 Volts wiring has no short circuits or accidental grounds. Perform insulation resistance tests on all wiring using an instrument which applies a voltage of approximately 500 volts to provide a direct reading of resistance. Minimum resistance shall be 1 megohm. The conductor loop resistance of each pair shall also be measured. The mutual capacitance between conductors of each pair shall also be measured. Provide written results for approval.

3.05 WIRE AND CABLE INSTALLATION

- A. Conductors shall not be pulled into raceway until:
 - 1. Raceway system has been inspected and approved by the ENGINEER.
 - 2. Plastering and concrete have been completed in affected areas.
 - 3. Raceway system has been freed of moisture and debris.
- B. Conductors of No. 8 size and smaller shall be hand pulled. Larger conductors may be installed using power winches. Wire pulling lubricant, where needed, shall be U.L. approved. Wire in panels, cabinets, and gutter shall be neatly grouped, using nylon tie straps, and fanned out to terminals.
- C. Building wire conductors THHN / THWN installed below grade, or in concrete slabs on grade, shall have type RHW-USE insulation, 600 Volts. Building wire shall be stranded.
- D. Each cable or wire in panels, pull boxes, manholes, or troughs shall have a permanent identification, with numbers and letters indicated on the conduit and cable schedule. For underground cable identification tag, see drawing.
- E. Lubricants – Lubricants for assisting in the pulling of cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings, and shall be U.L.

approved. Use Polywater J or equal.

- F. Cable Pulling Tensions – Shall not exceed the maximum pulling tension recommended by the cable manufacturer.

3.06 MOUNTING AND SUPPORTING ELECTRIC EQUIPMENT

- A. Furnish and install all supports, hangers, and inserts required to mount fixtures, conduits, cables, pull boxes, and other equipment furnished under this section or furnished for installation under this section.
- B. All items shall be supported from the structural portion of the building and studs, except standard ceiling-mounted lighting fixtures and small devices, that may be supported from ceiling system where permitted by the ENGINEER. However, no sagging of the ceiling will be permitted. Supports and hangers shall be of types approved by Underwriter's Laboratories.
- C. Perforated straps and wire are not permitted for supporting electrical devices. Anchors shall be of approved types.
- D. All supports, hangers, hardware, etc. used outdoors, shall be stainless steel and in corrosive atmosphere, or in hazardous areas shall be nonferrous, corrosion resistant, or stainless steel. Supports shall be selected to avoid galvanic reactions. Support devices shall be submitted for approval.

3.07 UNDERGROUND WORK

- A. **Excavation for Electrical Work**
Excavation or drilling, backfill and repair of paving and grassing is to be in the bid of the electrical contractor. The actual work need not be performed by electrical trades. However, the electrical contractor is responsible for all excavation, drilling, dewatering, backfilling, tamping, and repair of pavements and grassing required in support of electrical work. All areas disturbed by electrical work shall be repaired to their original conditions, or as indicated on the Drawings.
- B. **Coordination**
The electrical contractor must check for existing utilities before commencing any excavation or drilling. Contract Drawings and other trades are to be consulted to avoid interference with other utilities on this project. In the event of damage to existing utilities, the OWNER and ENGINEER shall be immediately notified, and the damage shall be immediately repaired at no cost to the Owner.
- C. **Precautions**
The electrical contractor must take every reasonable precaution to avoid interferences. In the vicinity of a suspected interference, excavations shall be dug by hand.
- D. **Excavating, Drilling and Backfilling**
 - 1. Materials for backfill shall be as specified in Specification 02222 - Excavation and Backfill for Utility Systems, Section 2.02.

2. Locate and protect existing utilities and other underground work in a manner which will insure that no damage or service interruption will result from excavating and backfilling.
3. Protect property from damage which might result from excavating and backfilling.
4. Protect persons from injury at excavations, by shoring up, and using barricades, warnings and illumination.
5. Coordinate excavations with weather conditions, to minimize the possibility of washouts, settlements, and other damages and hazards.
6. Dewater excavations as necessary. Protect excavations from inflow of surface water. Pump minor inflow of ground water from excavations; protect excavations from major inflow of ground water by installing temporary sheeting and waterproofing. Provide adequate barriers which will protect other excavations and below grade property from being damaged by water, sediment, or erosion from or through the electrical work excavations.
7. No organic material is permitted in backfill. All vegetation, peat, sod or other organic matter shall be removed from the premises.
8. Except under roadways, backfill material shall be clean sand or shell rock. No debris or trash may be used as backfill.
9. Under roadways, backfill material shall be the same as comprising the road bed.
10. Backfill excavations using 8-inch high courses of backfill material, uniformly compacted to 95 percent density per ASTM Standard D1557, using power-driven, hand-operated compaction equipment. Watering the backfill for compaction is not an acceptable method.
11. Backfill to elevations matching adjacent grades. Where subsidence is measurable or observable at electrical work excavations during the warranty period, remove the surface (pavement, lawn or other finish) add backfill material, compact, and replace the surface treatment. Restore the appearance, quality, and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.
12. Where excavation and backfill for electrical work passes through or occurs in a landscaped area, repair or replace the landscape work to match the original condition and quality of work.
13. Where excavation and backfill for electrical work passes through or occurs in an area of paving or flooring, replace and restore the construction and finish of the paving or flooring to match the original condition and quality of the work.

E. Underground

1. Underground conduits not under concrete slabs, shall be buried at least two feet below finished grade for circuits rated 600 volts or less, except under traffic areas, conduits shall be buried at least three feet below finished

grade.

2. Where steel conduit penetrates ground or concrete, the conduit shall be painted with two coats of asphaltic base paint one foot on each side of penetration.
3. Transition from PVC to RGS shall be made prior to elbow below grade. Paint RGS with bitumastic, 12 inches above and below grade.

3.08 CONCRETE MANHOLES AND PULL BOXES

- A. Provide precast concrete manholes and pull boxes as indicated on the drawings. Manholes and pull boxes shall be installed on firmly compacted ground level and plumb at the elevations indicated on the drawings. Manholes and pull boxes shall be equipped with pulling-in irons opposite and below each ductway entrance. Manholes and pull boxes shall have cable supports so that each cable is supported at a minimum of 3 feet intervals within the manhole or pull box. Cable supports shall be fastened with galvanized bolts and shall be fabricated of fiberglass or galvanized steel.

Make provision for drainage and grounding. Install grounding rods at each manhole.

- B. Traffic Covers – H-2-044 traffic rated covers shall be provided for manholes and pull boxes with identification as follows:

ELECTRIC" where voltages within are 600 volts and less.

"SIGNAL" for instrumentation, telephone, and control.

- C. Covers and frames shall be cast iron or hot dip galvanized.

End bells shall be cast in boxes by precast manhole manufacturer for all conduit entrances indicated on the drawings.

- D. Every manhole shall be equipped with 24" x 24" concrete knockouts for future conduit installation on two opposing walls.

3.09 CONDUIT INSTALLATION

- A. General – Conduits in structural slabs shall be placed between the upper and the lower layers of reinforcing steel, requiring careful bending of conduits. Conduits embedded in concrete slabs shall be spaced not less than eight inches on centers or as widely spaced as possible where they converge at panels or junction boxes. Conduits running parallel to slab supports, such as beams, columns and structural walls, shall be installed not less than 12 inches from such supporting elements. To prevent displacement during concrete pour, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured.

3.10 WIRE AND CABLE INSTALLATION

- A. Installation of Cables in Manholes, Handholes, and Vaults. Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form all cables to closely parallel walls, not

to interfere with duct entrances, and support on brackets and cable insulators. In existing manholes, handholes and vaults where new ducts are to be terminated, or where new cables are to be installed, the existing installation of cables, cable supports, and grounding shall be modified as required for a neat and workmanlike installation, with all cables properly arranged and supported. Support cable splices in underground structures by racks on each side of the splice. If splicing is approved, locate splices to prevent cyclic bending in the spliced sheath and out of the water. Install cables at middle and bottom of cable racks, leaving top space opening for future cables, except as otherwise indicated. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

- B. Cable Markers (or tags) in Manholes and Handholes – Provide cable markers or tags for each cable or wire passing through or leaving manholes or handholes and at each terminal. Tags shall be stainless steel, bronze, lead strap, or copper strip, approximately 1/16 inch thick, or hard plastic 1/8 inch thick, suitable for immersion in salt water, and of sufficient length for imprinting the legend on one line, using raised letters not less than 1/4 inch in size, and shall be permanently marked or stamped with the identification as indicated. Use of two color laminated plastic is acceptable. Plastic markers shall be dark in color, and markings shall be light in color to provide contrast so that identification can be easily read. Fastening material shall be of a type that will not deteriorate when exposed to water with a high saline content.
- C. All supports, hangers, hardware, etc. used outdoors, shall be stainless steel. In corrosive atmosphere, or in hazardous areas, shall be non-ferrous, corrosion resistant, or stainless steel. Supports shall be selected to avoid galvanic reactions. Support devices shall be submitted for approval.
- D. Spare conduits shall be on top or accessible sides and identified uniquely at each location and active conduits shall be located on the bottom unless noted otherwise.

END OF SECTION

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SECTION 16110

RACEWAY AND BOXES

PART 1 - GENERAL

1.01 SCOPE

- A. This Section includes basic materials and electrical methods for all of Division 16, Electrical and Related Work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Concrete - Division 3

PART 2 - PRODUCTS

2.01 RACEWAYS AND FITTINGS

- A. Rigid Metal Conduit – Hot-dipped galvanized heavy wall rigid steel conduit shall be used on all electrical and instrumentation systems. Conduit shall conform to Federal Specification WW-C-581d and fittings shall conform to Federal Specification W-F-408, Type I and III, Class 1, Style 2.
- B. Liquid Tight Flexible Metal Conduit – Flexible metal conduit shall be used on all electrical and instrumentation systems. Liquid tight flexible conduit shall conform to NEC Article 351 as manufactured by Appleton, Robroy, or Anaconda. Fittings shall be as manufactured by Midwest or Robroy and conform to Federal Specification W-F-406b, Type I, Class 3.
- C. Rigid Non-Metallic Conduit – Polyvinyl chloride (PVC) conduit, boxes and fittings shall conform to NEMA TC-2 and to Military Specifications MIL-C-23571 for Type II, Schedule 40 and shall be used on specified grounding and utility company systems only.
- D. Wireways and Auxiliary Gutters – Wireways and auxiliary gutters shall be galvanized steel with removable covers unless indicated as hinged. Components shall be as manufactured by Square 'D', Hoffman, Keystone, or General Electric. All wireways shall be without manufactured knockouts.

2.02 BOXES AND ACCESSORIES

- A. Sheet steel boxes and accessories shall conform to Federal Specification W-J-800c, as manufactured by Appleton, Steel City, or Raco.
- B. Cast metal ferrous outlets shall conform to Federal Specification W-C-568a, as manufactured by Appleton, Pyle-National, or Crouse-Hinds.
- C. Pull boxes and junction boxes larger than 4-11/16" shall be constructed of galvanized steel in accordance with NFPA 70, Articles #370 and #373. Boxes shall be as manufactured by Hoffman, Boss, or Keystone. All boxes shall be without manufactured knockouts.
- D. Cast, malleable iron outlet boxes shall have threaded conduit entrances and gasketed covers. Aluminum-type is not permitted. Boxes shall have a minimum of two hubs on the bottom, as manufactured by Appleton or Crouse-Hinds.

- E. Concrete pull boxes shall be of the open bottom type, with an iron, locking cover marked "ELECTRIC" or "SIGNAL" as applicable, and shall be U.L. Listed and meet all codes.
- F. Rigid Conduit Coupling – Where rigid steel conduit is used, jointing conduit runs shall be connected by a threaded coupling or three piece couplings. Threadless coupling will not be permitted.
- G. Rigid Conduit Bushing – Where rigid steel conduit is used, all terminations in boxes, panels, etc. shall have locknuts on both sides of equipment, with a bonded, grounding bushing.
- H. Field Cut Threads – Field-cut threads must be cleaned with oil and painted with a coat of aluminum, or galvanized paint. Newly cut threads that are not coated will have rust or corrosion develop, and will inhibit the grounding path of the conduit run.
- I. Conduit Nipples – The use of all-thread is prohibited.

2.03 EXPANSION FITTINGS

- A. Any expansion fittings used shall be manufactured by O-Z Electrical Manufacturing Company, and specified as follows: Rigid metal conduit - Type AX; Electrical metallic tubing - Type TX.
- B. Miscellaneous – Coatings – Tnemec 46-465

PART 3 - EXECUTION

3.01 RACEWAYS

- A. Use rigid, non-metallic conduit as follows, unless noted otherwise: Grounding systems and utility systems only.
- B. Paint metal conduit in floor slab or in the ground with 2 coats of Tnemec 46-465.
- C. Use liquid tight, flexible metal conduit for all connections to vibrating equipment, such as motors, valves, and devices on piping or ductwork. The maximum length shall be restricted to 18" or less, any longer lengths must have approval. It shall be restricted for use within 24 inches above the floor elevation. (A green bonding conductor will be required in all runs, with other conductors.)
- D. Install exposed conduit parallel with, or at right angles to the building lines. Conduit larger than 1", except as indicated, in reinforced concrete slabs shall be parallel with, or at right angles to the supports of the slab. Conduit in concrete shall be located so as not to affect the structural strength of the slabs. Conceal all conduits in walls, above ceilings, in or under slabs or in furring, except in mechanical and electrical rooms and as indicated.
- E. Route feeders, home runs, and conduits where indicated, except those minor deviations as approved, will be permitted.
- F. All conduits that are embedded in concrete, pass through concrete, or stub-up shall have a 30 mil coating of Tnemec 46-465 over its entire length where embedded in concrete, and 12 inches before entering and 12 inches after exiting the concrete.

3.02 BOXES AND ACCESSORIES

- A. Minimum size outlet box shall be 4" square by 1-1/2" deep unless otherwise approved or indicated otherwise.
- B. Use cast malleable iron boxes for outlets with gasketed covers for all exterior and for all damp locations.

3.03 MISCELLANEOUS

- A. Provide approved fire stopping materials at all chases to prevent drafts.
- B. Provide expansion fittings in conduit runs crossing expansion joints in the structure.
- C. Provide Jet Line #232 in all empty conduits.
- D. Rigid Conduit fitting shall be cast, malleable iron, with stamped, galvanized steel, stainless steel screw covers, and gasket for use inside. Outside cast malleable iron galvanized, stainless steel screw and gasket.

END OF SECTION

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SECTION 16120

CONDUCTORS

PART 1 - GENERAL

This Section includes basic materials and methods for all of Division 16, Electrical and Related Work.

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Signal Conductors

1.02 APPLICABLE REQUIREMENTS

NEC Article 310 and 400

F.S.J-C-30

F.S.W-S-6106

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Conductors shall conform to Federal Specification J-C-30 for 600 volts, Types THWN/THHN, or XHHW stranded or as shown on the drawings. Sizes are AWG unless otherwise noted.
- B. Grounding conductors larger than Size 1 AWG shall be soft drawn, bare copper or insulated copper. Control conductors for 100 to 600 volts shall be size 14 AWG copper, stranded, and color coded unless indicated otherwise.
- C. Control conductors for 50 volts and under shall be plastic jacketed thermostat cable, Size 18 AWG single conductor, copper, multi-conductor as required. Fixture wire shall be Type THHN for all through wiring where permitted.

2.02 PORTABLE CORDS

- A. Portable cord shall be stranded copper, UL Listed, and resistant to water, acid, and alkalis.
- B. Each cord shall have one green covered conductor that shall be used as a grounding conductor.

2.03 SPLICES AND TERMINATIONS

- A. Connections shall comply with Federal Specification W-S-610b. Connectors for temperatures to 105NC shall be Ideal Wing Nut or 3M-Scotchloc.
- B. Tape shall be Scotch 33 or slip-knot grey. Voids shall be filled with rubber tape or Scotch fill.
- C. Terminal boards shall be General Electric, Type CR151, type A2. Lugs for the terminal boards shall be the locking tongue type. Control terminals and motor connections up to size 3 shall be ring tongue type as manufactured by T&B Sta-Kon.
- D. Heat shrink for all splices outdoors. Insulating and sealing of all in-line, cable splices from 16 AWG through 1000 kcmil shall be done in accordance with the instructions

provided with the Shrink-Kon heat shrinkable insulators, catalog series HS as manufactured by Thomas & Betts.

- E. The connector insulator must be made of thermally stabilized, homogeneous polyolefin having internally applied sealant. It must have Underwriter's Listing (UL48, 90NC, 600V) and be approved for the use. It must be usable without additional covering or adhesive, both indoors and outdoors, in overhead, direct buried, or submersed applications at rated voltage. It must not be adversely affected by moisture, ozone, oils, fuels, mild acids and alkalis, or ultraviolet light. It must be compatible with all commonly used cable jacket materials including rubber, plastic, lead, steel, aluminum, and copper. All conductors larger than #10 shall have Noalox Non-Corrosive Paste applied to wires' ends and terminals before connections are made. This will prevent or retard corrosion.

PART 3 - EXECUTION

3.01 CONDUCTORS

- A. Conductors size 10 AWG and smaller shall be copper and have insulation colored for phases A, B, and N respectively as follows for single phase systems: 120/240 volts, black, red, and white.
- B. All-bonding conductors shall have a green covering and shall be the same size as the circuit conductors unless otherwise indicated.
- C. Installation of conductors shall be made only in completed raceway systems and all conductors in any conduit shall be pulled in together.
- D. Use wire pulling compounds or lubricants as listed by Underwriters' Laboratories or talc, graphite, or soapstone.

3.02 SPLICES AND TERMINATIONS

- A. Use solder-less terminal lugs on all standard conductors. Use approved solder-less connectors for all splices. Keep splices to a minimum.
- B. Splice all neutrals prior to connection to wiring devices. Splices other than pre-insulated connectors shall be covered neatly with insulation type equivalent in value to the conductor insulation. Use minimum of 2 layers of tape.

3.03 PHASING AND IDENTIFICATION

- A. The phase designation of all secondary conductors shall be the same and shall be indicated in or on all 3-phase outlets, transformers, panelboards, and disconnect switches, and they shall be connected with uniform phase sequence.
- B. Control wiring shall have a Brady® label or equal attached, secured with a clear piece of heat shrink tubing over the numbers. The numbers shall be attached 1 inch from each end. Tag each individual conductor or wire with a label stating the terminal designation indicated on schematic diagrams, or given on manufacturer's equipment lists, and at each terminal strip, relay, etc.

3.04 NUMBER OF CONDUCTORS

- A. For convenience and simplicity, wire tics are shown only on home runs other than power circuits. The Contractor shall determine the correct combination of wires to be run in all raceways including home runs, branch circuit wiring and switch legs.

- B. A green ground wire must be included in all conduits. Neutral wires shall be determined by the load and proper phasing on multi-wire branch circuits.
- C. All conductors shall have identification per NEC and local codes.
 - 1. Colored tape for feeder conductors should be secured on the conductor with clear piece of heat shrink tubing.
- D. Conduit fill shall be sized per National Electric Code. All 120 volt circuits shall each have individual neutrals.

3.05 TESTING

- A. After wiring has been pulled in raceways and before hook-up, wires shall be subject to an insulation test. A Megohmmeter of 500 volts shall be used, and a minimum of 10 megohms will be acceptable. Test shall be witnessed by the ENGINEER. A 48-hour notification must be given before test(s) commence. It is typical that wire was abused during installation, usually due to lack of lubrication. The test will reveal any damage to insulation on wiring.

END OF SECTION

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SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

Basic Materials & Methods

1.02 APPLICABLE DOCUMENTS

NEMA WD-1	-	Wiring Devices, Non-locking
NEMA WD-5	-	Wiring Devices, locking type
F.S. W-S-896c	-	Toggle Switch
F.S. W-P-455a	-	Wall Plates

PART 2 - PRODUCTS

2.01 RECEPTACLES

- A. All receptacles shall be the grounding type and shall conform to applicable portions of NEMA Standards WD-1 and WD-5.

NEMA Configuration - #5-20, duplex, Ivory

P & S #5342-I

Leviton - #5342-I

NEMA Configuration #1050

Hubbell - 7512-G receptacle

Hubbell - 7118 stainless steel plate

Hubbell - 7914 cord set (length as required)

2.02 SWITCHES

- A. Toggle switches shall conform to Federal Specification W-S-896c, A.C., only type switch.

20 Amperes, 120-277 volt, Ivory

Leviton - 1121-I, 1123-I

P & P - 521-I, 523-I

2.03 PLATES AND COVERS

- A. Wall plates for recessed devices shall conform to Federal Specification W-P-455a and shall be of Ivory color with matching screws unless indicated otherwise, and of the configuration required for the devices installed.

Leviton - 86000 Line, P & S or equal

Surface (raised) covers for 4" square boxes shall be 1/2" deep.

Surface covers shall be as manufactured by Steel City, Appleton or Raco of the configuration required. Cover plates indicated (WP) weatherproof shall be made of Type 302 stainless steel with stainless steel springs, screws and gaskets. Sierra Series "WP" of the configuration required.

2.04 ATTACHMENT CAPS AND CONNECTORS

- A. Caps shall be NEMA Standard mates to the receptacles and connectors used and shall be as manufactured by Hubbell. Provide one cap for each receptacle other than the duplex type.
- B. Electrical contractor shall connect all equipment furnished by Owner or other contractors, including caps and cords and materials required to complete the installation.

PART 3 - EXECUTION

3.01 INSTALL PLATES AND COVERS ON ALL OUTLETS. INSTALL ALL DEVICES UNIFORMLY IN EACH AREA. USE 20 AMPERE SWITCHES AND RECEPTACLES EVERYWHERE.

3.02 INSTALL A CORD AND CAP (PLUG) ON ALL EQUIPMENT INDICATED "C & P" ON THE SCHEDULES. CONNECT THE TOP HALF OF SPLIT RECEPTACLES HOT AND USE THE BOTTOM AS THE SWITCHED SECTION. TEST EACH SOCKET OF EACH OUTLET WITH A DEVICE INTENDED FOR THIS PURPOSE. GANG SWITCHES AND DIMMERS WERE FEASIBLE.

3.03 MOUNTING HEIGHTS (TO CENTER LINE OF BOX):

- A. Generally, mount outlets 36" up unless noted.
- B. Mount switches and dimmers at 48" up.
- C. Mount outlets over mirrors 8" higher than mirror.
- D. Mount outlets over counters and centered in the back splash where it occurs.
- E. Adjust outlet heights in ceramic tile walls to be entirely in or entirely out of the tile.
- F. Outlets may be horizontal to meet space conditions.
- G. Mount exhaust fan thermostats 2' from ceiling and bypass switch 48" from finished floor.

END OF SECTION

SECTION 16160

PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Basic Materials and Methods
- B. Section 16180 – Circuit Breakers, Switches & Fuses
- C. Starters
- D. Contactors

1.02 APPLICABLE DOCUMENTS

- A. NEMA PB-1, 1957 - Panelboards
- B. F.S. W-P-115a - Panelboards
- C. NFPA-70 - Articles 110, 240, 384

1.03 SUBMITTALS

- A. Submit Shop Drawings for review on each panelboard indicating cabinet dimensions, component arrangements, characteristics, and sizes.

PART 2 - PRODUCTS

2.01 PANELBOARDS

- A. Panelboards shall conform to Federal Specification W-P=115a, complete with cabinets and locks. Fronts shall be finished to resist corrosion with not less than one priming coat and one pearl gray finishing coat. Components shall be arranged approximately as indicated. Bus shall be copper.
- B. Circuits shall be numbered serially from top to bottom with odd numbers on the left. Adjacent poles of single pole devices shall be of opposite polarity with split-phase bussing.
- C. Provide keys, each of which will operate all the panelboard cabinet locks. Provide a typewritten directory with a transparent protective cover on the inside of the panelboard cover. Panels shall be factory assembled and tested. Circuit breaker panelboards shall be Type I, Class 1, bolt-on type.
- D. Panelboards shall be as manufactured by Square “D”, Siemens, or Eaton Corporation.
- E. Panelboard bus shall be copper.

PART 3 - EXECUTION

3.01 GENERAL

- A. Mount all panels with tops at 6' above the floor, except as noted or approved otherwise. Mount grouped equipment on backboards. Identify all panels and all devices. Nipple all adjacent panels together using minimum 1-1/2" conduit. Clean all debris out of cabinets prior to installing covers. Provide a minimum of two empty conduit stubs from flush mounted panels to ceiling spaces above and below.

END OF SECTION

SECTION 16180

SAFETY SWITCHES, CIRCUIT BREAKERS & FUSES

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE:

Panelboards - Section 16160

Applicable Documents:

NEMA AB-1 - Molded Case Circuit Breakers
NEMA IC-1 - Industrial Control
F.S. W-S-865c - Enclosed Switches
F.S. W-C-375a - Circuit Breakers
U.L.-198 - Fuses
NEMA FU-1 - Fuses

1.02 SUBMITTALS:

Submit Shop Drawings for review including catalog cuts showing sizes, types and characteristics of all products.

PART 2 - PRODUCTS

2.01 SAFETY SWITCHES/CIRCUIT BREAKER DISCONNECTS:

- A. Safety switches shall conform to Federal Specifications W-S-865c, heavy duty type HD, fusible or non-fusible, with the poles, ampere, voltage and horsepower ratings indicated and shall have solid neutrals and Class R clips. Lugs shall be U.L. listed for copper-aluminum.
- B. Enclosures for safety switches shall be NEMA-1, general purpose, except that switches indicated (WP) weatherproof, shall be NEMA-3R unless marked NEMA-4X. Provide hubs as required for NEMA-3R enclosures with suitable gaskets and bonding means.
- C. Switches and disconnects shall be as manufactured by Square 'D', General Electric, Siemens, or Eaton.
- D. Circuit breaker disconnects may be used in lieu of safety switches providing they comply with the safety switch requirements and are applied within their ratings and a schedule is submitted for approval.

2.02 CIRCUIT BREAKERS, MOLDED CASE:

- A. Circuit breakers shall conform to Fed. Spec. W-C-375a and NEMA Standard AB-1 unless indicated otherwise. Circuit breakers shall be of the ampere rating, voltage rating, number of poles and class or interrupting capacity (I.C.) as indicated. Interrupting ratings are given in root mean square (RMS), symmetrical amperes based on NEMA test procedures. Lugs and terminals shall be U.L. listed for copper-aluminum. Accessories shall be 120 volts.
- B. Each circuit breaker shall have a trip unit for each pole with elements providing

inverse time delay under overload conditions and instantaneous magnetic trip for short circuit protection unless indicated as non-automatic. Trip elements shall operate a common trip bar to open all elements.

2.03 FUSES:

- A. Provide rejection fuses for all fusible equipment regardless of which section has furnished such equipment.
- B. Fuses shall be of the ratings shown on the drawings, U.L. listed and shall be Bussman Manufacturing Co., Gould-Shawmut Company, CEFCO or approved equal.
- C. All fuses shall be current limiting and have an interrupting capacity of at least 200,000 amperes RMS symmetrical.
- D. The time-current characteristics and ratings shall be such that positive selective coordination is assured.
- E. Fuses, 600 amperes and lower, where applied to general feeder and branch circuit protection, shall conform to U.L. Class RK-1 standards and be Bussmann Type LPN-RK-SP LPS-RK-SP, "Low Peak". Gould-Shawmut dual element "Amp-Trap."
- F. Fuses, where required for circuit breaker protection shall conform to U.L. Class RK-1 standards and be Bussmann Type LPN-RK-SP or LPS-RK-SP "Low Peak", or Gould-Shawmut Class RK1 "Amp-Trap."
- G. Coordination and current limitations or the protection of each part of the electrical system must be designed around the type and class and manufacturer selected for that type and class.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Mount grouped switches, disconnects and controls on backboards or unistrut. Provide labels on or in all fusible equipment indicating the type and size replacement fuse required.
- B. Generally, mount switches and disconnects between 4' and 5' A.F.F., readily accessible.

3.02 FUSES:

- A. Install all fuses as required where indicated on the drawings and where required by the National Electrical Code, special attention shall be given to air conditioning equipment.
- B. Provide 10% spares (minimum of three) of each size and type of fuses furnished. Spare fuses shall be placed in a wall mounted cabinet equal to: Bussmann SFC which shall be located in the switchgear room.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes equipment identification labels.

1.03 SUBMITTALS

- A. Product Data – For each electrical identification product indicated.
- B. Identification Schedule – An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.04 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

PART 2 - PRODUCTS

2.01 UNDERGROUND-LINE WARNING TAPE

- A. Tape
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical, controls and I&C raceways.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing
1. Comply with ANSI Z535.1 through ANSI Z 535.5.
 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, LOW VOLTAGE.
 3. Inscriptions for Orange-Colored Tapes: I&C CABLE, OPTICAL FIBER CABLE.

2.02 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label – Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify identification of each item before installing identification products.
- B. Location – Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to services that require finish after completing finish work.
- D. Self-Adhesive Identification Products – Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Underground-Line Warning Tape – During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.02 IDENTIFICATION SCHEDULE

- A. Locations of Underground Lines – Identify with underground-line warning tape for electrical, controls and I&C wiring and optical fiber cable.
- B. Equipment Identification Labels – On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems requiring labels include power, lighting, control, and I&C unless equipment is provided with its own identification.
1. Labeling Instructions
 - a. Indoor Equipment – Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½” (inch) high letters on 1-1/2” (inch) high label; where two lines of text are required, use labels 2 inches high. Utilize white

lettering on black background.

- b. Outdoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½" (inch) high letters on 1-1/2" (inch) high label; where two lines of text are required, use labels 2 inches high. Utilize white lettering on black background.

2. Equipment to be Labeled

- a. Enclosures and electrical cabinets
- b. Motor Control Centers
- c. Enclosed switches
- d. Variable Frequency Drives
- e. Monitoring and control equipment

END OF SECTION

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SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 SCOPE

This Section includes basic materials and methods for all Division 16 and related electrical work.

1.02 APPLICABLE REQUIREMENTS

NEC Article 250

PART 2 - PRODUCTS

2.01 GROUNDING ELECTRODES

Grounding Electrodes shall be a minimum of 5/8" diameter by 10' length & copper-clad, unless otherwise specified. Grounding accessories shall be as manufactured by Burndy, Erico or Thompson.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. End to end fixtures shall be continuously bonded. Grounding contact of receptacles shall be connected to a solidly grounded conduit system or to a system grounding conductor (not the system neutral) by a stranded copper wire not smaller than 12 AWG or shall be grounded in some other approved manner.
- B. Bond all metal parts. Make equipment and bus connections with suitable lugs or clamps. Cadweld all wire-to-ground rod joints. Cadweld all wire-to-wire joints size 1/0 AWG and over.
- C. Bond all conduits stubbing under switchboards, transformers and similar locations using bonding bushings. Bond each conduit separately.
- D. Provide a bonding wire from grounding bushings on all conduit terminated at panels, boxes, wireways, panels, etc.
- E. Provide a bond wire in all flexible metal conduits and connect to the boxes at each end in an approved manner.
- F. Use PVC to sleeve grounding conductors, except that where sleeves are subject to extreme injury use rigid metal conduit bonded at both ends.
- G. Ground all separately derived sources such as transformers to adjacent cold-water pipe or building steel in accordance with NEC.
- H. Grounding of all equipment should be accomplished with lugs equal to T & B "Locktite" one bolt hole tongue #31003 or equal.
- I. All conduit to Service entrance equipment and Transfer Switch along with Load Center shall have Grounding Bushing on all conduit and ground to box, cabinet, etc.

This will give an added protection in grounding all the electrical systems.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the lighting fixtures, lamps, trim, ballasts, poles, bases, accessories.

1.02 APPLICABLE DOCUMENTS

- UL-57 - Standard of Electric Fixtures
- FS-W-L-101 - Lamps, Incandescent
- FS-W-L-116 - Lamps, Fluorescent
- FS-W-B-30 - Ballasts
- FS-W-F-414 - Fixtures, Fluorescent
- I.E.S. - Illuminating Engineering Society Handbook, 10th Edition

1.03 QUALIFICATIONS

- A. Photometric data of independent, nationally recognized testing agencies will be accepted. Photometric data of testing laboratories of fixture manufacturers may be accepted if certified.

1.04 SUBMITTALS

- A. Submit Shop Drawings for each luminaire assembly consisting of catalog cuts, photometric data, dimensions, ballast data, voltage, materials finish and installation data.
- B. Submittals shall be bound in a manual, indexed and identified in accordance with schedules.
- C. Submit wind load calculations on pole assemblies - based on the wind loading requirements of the current edition of the Florida Building Code (F.B.C.). Indicate shape factors, moments and stresses.

PART 2 - PRODUCTS

2.01 FIXTURES, GENERAL REQUIREMENTS

- A. Lighting fixtures shall be as indicated or specified. The details, shapes and dimensions are approximate, and variations, when approved, may be made in order to use stock fixtures.
- B. Lighting fixtures shall conform to U.L. publication #57, and shall be complete with lamps and all necessary accessories and fittings.
- C. Lens frames shall be supported so as to avoid sagging, and shall be readily removable or suitably hinged and latched. Removable frames shall have adequate means of retention for use when servicing.

- D. LED luminaires shall be identical in construction features, options and appearance to the luminaires specified in the Luminaire Schedule.
- E. LED luminaires shall be provided with all cables, controllers, power supplies, connectors, terminators and accessories required for a complete installation. LED system shall utilize pulse width modulation, non-linear scaling techniques and reverse polarity protection for high resolution output.
- F. LED luminaires shall be high brightness and binned for forward voltage, luminous flux and wavelength.
- G. LED luminaires shall be tested in accordance with IESNA LM-79 (luminous output, power input, luminaire efficacy (lumens/watt), color temperature and color rendering index) and IESNA LM-80 (output luminous maintenance, 10,000 hours minimum test). Luminaire output shall be a minimum of 60 lumens/watt. Rated life shall be a minimum of 50,000 hours at 50% output. Testing shall be performed by a US Department of Energy (DOE) accredited laboratory.
- H. LED drivers shall be solid state Class 1 power supply/driver. The system shall have a minimum 90% power factor and a maximum of 30% THD, and heat sensing with color sensing feed-back. Adequate heat sink capability shall be provided to ensure the rated life.
- I. LED drivers shall be solid state Class 1 power supply/driver. The system shall have a minimum 90% power factor and a maximum of 30% THD, and heat sensing with color sensing feed-back. Adequate heat sink capability shall be provided to ensure the rated life.
- J. The luminaires (to include LED lamps and LED drivers) shall have five (5) year minimum warranty for replacement and labor.
- K. Photocell - Provide photocell and lighting contactor for control of exterior lights.

PART 3 - EXECUTION

- 3.01 Adjust all directional fixtures to obtain the most uniform distribution. Orient all similar fixtures consistently. Coordinate fixtures with speakers, air grilles, pipes and ductwork.
- 3.02 Fixture bottoms, edges and ends of rows shall be even. Rows shall be straight, aligned and equally spaced in distinct areas. Clean all fixtures of debris and fingerprints and adjust trim to fit surfaces snug.
- 3.03 Provide all necessary hangers and mounting accessories for a complete installation. Precast pole bases shall be set in an augured hole and leveled using water and a vibrator. Poles shall be vertical.
- 3.04 Locate the fluorescent fixtures in the equipment rooms to best illuminate the equipment installed. Use chains or rods to support below ducts and pipes as required. Test all fixtures, switches and controls for operation. Replace all lamp burnouts if their estimated operating period is less than 80% rated lamp life prior to final acceptance.

END OF SECTION