DIVISION 16

ELECTRICAL

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding electrodes and conductors, equipment grounding conductors, and bonding to complete grounding system consisting of:

1. Existing metal underground water pipe.

2. Metal frame of the building.

3. Concrete-encased electrode.

4. Rod electrodes.

5. Plate electrodes.

6. Active electrodes.

1.02 REFERENCES

A. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

B. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals procedures.

B. Product Data: Provide for grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Project Record Documents: Record actual locations of components and grounding electrodes.

F. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 ELECTRODES

A. Rod Electrodes: Copper.

1. Diameter: size to conform to NFPA 70 requirements.

2. Length: length to conform to NFPA 70 requirements.

B. Active Electrodes: Metallic-salt-filled copper-tube electrode.

1. Shape: Straight.

2. Length: 8 feet.

3. Connector: U-bolt pressure plate.

C. Foundation Electrodes: 2/0 AWG.

2.02 CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.

B. Wire: Stranded copper.

C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

A. Install ground electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Install 4 AWG bare copper wire in foundation footing where indicated.

C. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond steel together.

D. Provide bonding to meet requirements described in Quality Assurance.

E. Bond together reinforcing steel and metal accessories in pool and fountain structures; in accordance with NFPA 70.

F. Install transient suppression plate where indicated.

G. Install ground grid under access floors where indicated. Construct grid of 2 AWG bare copper wire installed on 24 inch centers both ways. Bond each access floor pedestal to grid.

H. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use 2 AWG bare copper conductor.

I. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

J. Interface with lightning protection system installed under Section 13100.

3.03 FIELD QUALITY CONTROL

A. Owner will provide field inspection in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

END OF SECTION

SECTION 16070

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.02 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s catalog data for fastening systems.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized.

C. Anchors and Fasteners:

1. Concrete Structural Elements: Use precast inserts, expansion anchors, powder-actuated anchors, or preset inserts.

2. Steel Structural Elements: Use beam clamps, steel ramset fasteners, or welded fasteners.

3. Concrete Surfaces: Use self-drilling anchors or expansion anchors.

4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.

5. Sheet Metal: Use sheet metal screws.

6. Wood Elements: Use wood screws.

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

2. Obtain permission from City Engineer before drilling or cutting structural members.

B. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

C. Install surface-mounted cabinets and panelboards with minimum of four anchors.

D. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.

E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

C. Conduit markers.

D. Field-painted identification of conduit.

1.02 RELATED SECTIONS

A. Section 09900 - Paints and Coatings.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals procedures.

B. Product Data: Provide catalog data for nameplates, labels, and markers.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Locations:
   1. Each electrical distribution and control equipment enclosure.

C. Letter Size:

   1. Use 1/8 inch letters for identifying individual equipment and loads.

D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations, and appurtenant items.

2.02 WIRE MARKERS

A. Description: tape type wire markers.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings.

2.03 CONDUIT MARKERS

A. Location: Furnish markers for each conduit longer than 6 feet.

B. Spacing: 20 feet on center.

2.04 UNDERGROUND WARNING TAPE

A. Description: 4 inch wide plastic tape, detectable type colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplates to equipment front using screws.

C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

D. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

END OF SECTION

SECTION 16123

BUILDING WIRE AND CABLE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wire and cable for 600 volts and less.

B. Wiring connectors and connections.

1.02 RELATED SECTIONS

A. Section 02312 - Trench Excavation.

B. Section 02315 - Excavation.

C. Section 02316 - Fill and Backfill: Bedding and backfilling.

D. Section 16075 - Electrical Identification.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

C. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for each wire and cable type.

C. Test Reports: Indicate procedures and values obtained.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

E. Project Record Documents: Record actual locations of components and circuits.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 WIRING REQUIREMENTS

A. Concealed Dry Interior Locations: Use only building wire with Type THW insulation in raceway.

B. Exposed Dry Interior Locations: Use only building wire with Type THW insulation in raceway.

C. Wet or Damp Interior Locations: Use only building wire with Type THW insulation in raceway or direct burial cable.

D. Exterior Locations: Use only building wire with Type THW insulation in raceway or direct burial cable.

E. Underground Installations: Use only building wire with Type USE insulation in raceway or direct burial cable.

F. Use solid conductor for feeders and branch circuits 10 AWG and smaller.

G. Use stranded conductors for control circuits.

H. Use conductor not smaller than 12 AWG for power and lighting circuits.

I. Use conductor not smaller than 16 AWG for control circuits.

J. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

K. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

L. Conductor sizes are based on copper.

2.02 BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: NFPA 70, Type THW.

2.03 DIRECT BURIAL CABLE

A. Description: NFPA 70, Type UF.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

2.04 SERVICE ENTRANCE CABLE

A. Description: NFPA 70, Type SE.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: Type RH.

2.05 WIRING CONNECTORS

A. Split Bolt Connectors:

B. Solderless Pressure Connectors:

C. Spring Wire Connectors:

D. Compression Connectors:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

C. Verify that raceway installation is complete and supported.

D. Verify that field measurements are as indicated.

3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.03 INSTALLATION

A. Route wire and cable as required to meet project conditions.

1. Wire and cable routing indicated is approximate unless dimensioned.

2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.

B. Install wire and cable in accordance with the NECA "Standard of Installation."

C. Use wiring methods indicated.

D. Pull all conductors into raceway at same time.

E. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

F. Protect exposed cable from damage.

G. Use suitable cable fittings and connectors.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Clean conductor surfaces before installing lugs and connectors.

J. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

K. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

L. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

M. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

N. Trench and backfill for direct burial cable installation as specified in Sections 02315 and 02315. Install warning tape along entire length of direct burial cable, within 3 inches of grade.

O. Identify and color code wire and cable under provisions of Section 16075. Identify each conductor with its circuit number or other designation indicated.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.1.

END OF SECTION

SECTION 16131

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Conduit, fittings and conduit bodies.

1.02 RELATED SECTIONS

A. Section 16060 - Grounding and Bonding.

B. Section 16070 - Hangers and Supports.

C. Section 16075 - Electrical Identification.

D. Section 16138 - Boxes.

1.03 REFERENCES

A. ANSI C80.1 - American National Standard Specification for Rigid Steel Conduit -- Zinc Coated; latest edition.

B. ANSI C80.3 - American National Standard Specification for Electrical Metallic Tubing -- Zinc Coated; latest edition.

C. ANSI C80.5 - American National Standard Specification for Rigid Aluminum Conduit; latest edition.

D. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies; National Electrical Manufacturers Association; latest edition.

F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; latest edition.

G. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80); National Electrical Manufacturers Association; latest edition.

H. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; latest edition.

I. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals procedures.

B. Product Data: Provide for metallic conduit, flexible metal conduit, liquid tight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.

C. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. Conduit Size: Comply with NFPA 70.

1. Minimum Size: 3/4 inch unless otherwise specified.

B. Underground Installations:

1. More than Five Feet from Foundation Wall: Use plastic coated conduit or thickwall non-metallic conduit.

2. Within Five Feet from Foundation Wall: Use plastic coated conduit or thickwall nonmetallic conduit.

3. In or Under Slab on Grade: Use plastic coated conduit or thickwall non-metallic conduit.

4. Minimum Size: 3/4 inch.

C. Outdoor Locations Above Grade: Use rigid steel conduit or electrical metallic tubing.

D. In Slab Above Grade:

1. Use rigid steel conduit or electrical metallic tubing.

2. Maximum Size Conduit in Slab: one inch; 3/4 inch for conduits crossing each other.

E. Wet and Damp Locations: Use electrical metallic tubing or thickwall nonmetallic conduit.

F. Dry Locations:

1. Concealed: Use rigid steel conduit or electrical metallic tubing.

2. Exposed: Use electrical metallic tubing.

2.02 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

B. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.03 PVC COATED METAL CONDUIT

A. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.

B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.04 FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction.

B. Fittings: NEMA FB 1.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction with PVC jacket.

B. Fittings: NEMA FB 1.

2.06 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron compression type.

2.07 NONMETALLIC CONDUIT

A. Description: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.08 NONMETALLIC TUBING

A. Description: NEMA TC 2.

B. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

A. Install conduit in accordance with NECA Standard of Installation.

B. Install nonmetallic conduit in accordance with manufacturer's instructions.

C. Arrange supports to prevent misalignment during wiring installation.

D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

E. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

F. Fasten conduit supports to building structure and surfaces under provisions of Section 16070.

G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

H. Do not attach conduit to ceiling support wires.

I. Arrange conduit to maintain headroom and present neat appearance.

J. Route exposed conduit parallel and perpendicular to walls.

K. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

L. Route conduit in and under slab from point-to-point.

M. Maintain adequate clearance between conduit and piping.

N. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

O. Cut conduit square using saw or pipe cutter; de-burr cut ends.

P. Bring conduit to shoulder of fittings; fasten securely.

Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

R. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.

S. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch size.

T. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

U. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic.

V. Provide suitable pull string in each empty conduit except sleeves and nipples.

W. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

X. Ground and bond conduit as required.

Y. Identify conduit under provisions of Section 16075.

END OF SECTION

SECTION 16138

BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

1.02 RELATED SECTIONS

A. Section 16139 - Cabinets and Enclosures.

B. Section 16140 - Wiring Devices: Wall plates in finished areas.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies; National Electrical Manufacturers Association; latest edition.

C. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; latest edition.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; latest edition.

E. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Provide products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

B. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

C. Wall Plates for Finished Areas: As specified in Section 16140.

2.02 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Hinged Enclosures: As specified in Section 16139.

C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:

1. Material: Galvanized cast iron.

2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:

1. Material: Galvanized cast iron.

2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.

3. Cover Legend: "ELECTRIC".

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.02 INSTALLATION

A. Install boxes in accordance with NECA "Standard of Installation."

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

C. Coordinate installation of outlet boxes for equipment connected under Section 16155.

D. Set wall mounted boxes at elevations to accommodate mounting heights specified in section for outlet device.

E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.

1. Adjust box locations up to 10 feet if required to accommodate intended purpose.

F. Orient boxes to accommodate wiring devices oriented as specified in Section 16140.

G. Maintain headroom and present neat mechanical appearance.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

J. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

K. Use flush mounting outlet box in finished areas.

L. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

M. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

N. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

O. Use stamped steel bridges to fasten flush mounting outlet box between studs.

P. Use adjustable steel channel fasteners for hung ceiling outlet box.

Q. Do not fasten boxes to ceiling support wires.

R. Support boxes independently of conduit.

S. Use gang box where more than one device is mounted together. Do not use sectional box.

T. Use cast outlet box in exterior locations exposed to the weather and wet locations.

U. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.03 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

3.04 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 16139

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hinged cover enclosures.

B. Cabinets.

C. Terminal blocks.

D. Accessories.

1.02 RELATED SECTIONS

A. Section 16070 - Hangers and Supports.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; latest edition.

C. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association; latest edition.

D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 MAINTENANCE MATERIALS

A. Furnish two of each key.

PART 2 PRODUCTS

2.01 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, Type 1 steel enclosure.

B. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.

C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with white enamel.

D. Enclosure Finish: Manufacturer's standard enamel.

2.02 CABINETS

A. Boxes: Galvanized steel.

B. Backboard: Provide 3/4 inch thick plywood backboard for mounting terminal blocks. Paint matte white.

C. Fronts: Steel, flush type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.

D. Provide metal barriers to form separate compartments wiring of different systems and voltages.

E. Provide accessory feet for free-standing equipment.

2.03 TERMINAL BLOCKS

A. Terminal Blocks: NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.04 ACCESSORIES

A. Plastic Raceway: Plastic channel with hinged or snap-on cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA Standard of Installation.

B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner under the provisions of Section 16070.

C. Install cabinet fronts plumb.

3.02 CLEANING

A. Clean electrical parts to remove conductive and harmful materials.

B. Remove dirt and debris from enclosure.

C. Clean finishes and touch up damage.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Device plates and decorative box covers.

1.02 RELATED SECTIONS

A. Section 16138 - Boxes.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA WD 1 - General Requirements for Wiring Devices; National Electrical Manufacturers Association; latest edition.

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; latest edition.

D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Manufacturer's Installation Instructions.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 WALL SWITCHES

A. Wall Switches: NEMA WD 1, Heavy Duty, AC only general-use snap switch.

1. Body and Handle: Ivory plastic with toggle handle.

2. Ratings:
   a. Voltage: 120 volts, AC.
   b. Current: 20 amperes.

2.02 RECEPTACLES

A. Receptacles: NEMA WD 1, Heavy duty.

1. Device Body: Ivory plastic.

2. Configuration: NEMA WD 6, type as specified and indicated.

B. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.03 WALL PLATES

A. Decorative Cover Plates: Ivory, smooth plastic.

B. Jumbo Cover Plates: Ivory, smooth plastic.

C. Weatherproof Cover Plates: Gasketed cast metal with hinged.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.03 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 16155

EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED SECTIONS

A. Section 16131 - Conduit.

B. Section 16123 - Building Wire and Cable.

C. Section 16138 - Boxes.

D. Section 16140 - Wiring Devices.

1.03 REFERENCES

A. NEMA WD 1 - General Requirements for Wiring Devices; National Electrical Manufacturers Association; latest edition.

B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; latest edition.

C. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

1. Attachment Plug Construction: Conform to NEMA WD 1.

2. Cord Construction: NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in applicable Sections and in individual equipment sections.

C. Wiring Devices: As specified in Section 16140.

D. Flexible Conduit: As specified in Section 16131.

E. Wire and Cable: As specified in Section 16123.

F. Boxes: As specified in Section 16138.

2.02 EQUIPMENT CONNECTIONS

A. Electrical equipment shall be connected as indicated, as required and as directed:

1. Electrical Connection: Flexible conduit where required.

2. Electrical Connection: Cord and plug (NEMA 6-20R).

3. Provide field-installed disconnect switch.

4. Voltage: 120 volts, 1 phase, 60 Hz.

5. Load rating: Not applicable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 16210

ELECTRICAL UTILITY SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Meter bases.

1.02 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 SYSTEM DESCRIPTION

A. System Characteristics: 208Y/120 volts, single phase, two-wire, 60 Hertz.

B. Service Entrance: as acceptable to the electrical utility company.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with utility company written requirements and NFPA 70.

1. Maintain one copy of each document on site.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Meter Base: Furnished by utility company.

B. Utility Transformer Pad: Prefabricated precast concrete transformer pad with cable pit.

C. Other Components: As required by utility company.

PART 3 EXECUTION

3.01 PREPARATION

A. Arrange with utility company to obtain permanent electric service to the Project.

B. Verify that field measurements are as indicated on utility company drawings.

3.02 INSTALLATION

A. Install service rack, weatherhead, transformer pad, metering transformer cabinets, and meter base as required by utility company.

B. Install in accordance with NECA "Standard of Installation."

END OF SECTION

SECTION 16412

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fusible switches.

1.02 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; latest edition.

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; latest edition.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

E. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide switch ratings and enclosure dimensions.

C. Project Record Documents: Record actual locations of enclosed switches.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.

1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.

2. Handle lockable in OFF position.

3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

B. Enclosures: NEMA KS 1.

1. Interior Dry Locations: Type 1.

2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA Standard of Installation.

B. Install fuses in fusible disconnect switches.

C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.

END OF SECTION

SECTION 16423

ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manual motor controllers.

B. Magnetic motor controllers.

C. Combination magnetic motor controllers and disconnects.

1.02 RELATED SECTIONS

A. Section 16070 - Hangers and Supports.

B. Section 16075 - Electrical Identification: Engraved nameplates.

C. Section 16491 - Fuses.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches; National Electrical Manufacturers Association; latest edition.

C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; latest edition.

D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; latest edition.

E. NEMA ICS 6 - Industrial Control and Systems: Enclosures; National Electrical Manufacturers Association; latest edition.

F. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; latest edition.

G. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

H. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Test Reports: Indicate field test and inspection procedures and test results.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Maintenance Data: Replacement parts list for controllers.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Substitutions: See Section 01600 - Product Requirements.

2.02 MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, NO auxiliary contact, and push button operator.

B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and key operator.

C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and key operator.

D. Enclosures: NEMA ICS 6, Type 1.

2.03 AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower, with motor circuit protector.

B. Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

C. Two-Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.

D. Coil Operating Voltage: 120 volts, 60 Hertz.

E. Overload Relays: NEMA ICS 2; bimetal.

F. Motor Circuit Protector: NEMA AB 1, circuit breakers with integral instantaneous magnetic trip in each pole. All controllers shall include a three phase motor protector; Motor Saver Model 777, or acceptable equal.

G. Enclosures: NEMA ICS 6, Type 1.

2.04 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty oil-tight type.

C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

D. Pushbuttons: Unguarded type.

E. Indicating Lights: Transformer, incandescent type.

F. Selector Switches: Rotary type.

G. Relays: NEMA ICS 2.

H. Control Power Transformers: 120 volt secondary, primary as required, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.05 COMBINATION CONTROLLERS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.

C. Motor Circuit Protector: NEMA AB 1, circuit breakers with integral instantaneous magnetic trip in each pole. All controllers shall include a three phase motor protector; Motor Saver Model 777, or acceptable equal.

D. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.

E. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

2.06 SOFT START

A. All controllers for pump motors shall include soft start operation. The soft start shall provide adjustable ramp times for starting and stopping pumps to minimize system hammers. Soft starts shall be compatible with the controllers, and shall be acceptable to the City Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with NECA Standard of Installation.

B. Install enclosed controllers plumb. Provide supports in accordance with Section 16070.

C. Height: 5 feet to operating handle.

D. Provide fuses for fusible switches; refer to Section 16491 for product requirements.

E. Select and install overload heater elements in motor controllers to match installed motor characteristics.

F. Provide engraved plastic nameplates; refer to Section 16075 for product requirements and location.

G. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

H. Provide clearances around enclosed controllers according to NECA Standards.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.16.2.

END OF SECTION

SECTION 16425

VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable frequency controllers.

1.02 RELATED SECTIONS

A. Section 16075 - Electrical Identification: Engraved nameplates.

B. Section 16491 - Fuses.

1.03 REFERENCES

A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association; latest edition.

B. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives; National Electrical Manufacturers Association; latest edition.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; latest edition.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

E. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Manufacturer's Field Reports: Indicate start-up inspection findings.

G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.07 MAINTENANCE SERVICE

A. Provide service and maintenance of controller for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Substitutions: See Section 01600 - Product Requirements.

2.02 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

1. Employ microprocessor-based inverter logic isolated from power circuits.

2. Design for ability to operate controller with motor disconnected from output.

3. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.

C. Finish: Manufacturer's standard enamel.

2.03 OPERATING REQUIREMENTS

A. Rated Input Voltage: 208 volts, three phase, 60 Hertz.

B. Motor Nameplate Voltage: 200 volts, three phase, 60 Hertz.

C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

D. Operating Ambient: 0 degrees C to 40 degrees C.

E. Minimum Efficiency at Full Load: as per manufacturer’s standard design.

F. Time to Stop: as per manufacturer’s recommendations.

G. Volts Per Hertz Adjustment: Plus or minus 10 percent.

H. Current Limit Adjustment: 60 to 110 percent of rated.

I. Acceleration Rate Adjustment: 0.5 to 30 seconds.

J. Deceleration Rate Adjustment: 1 to 30 seconds.

K. Input Signal: 4 to 20 mA DC.

2.04 COMPONENTS

A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.

B. Status Indicators: Separate indicators for over-current, over-voltage, ground fault, over-temperature, and input power ON.

C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.

D. Include undervoltage release.

E. Control Power Source: Separate circuit.

F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.

G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.

H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.

I. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.

J. Emergency Stop: Use dynamic brakes for emergency stop function.

K. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.

L. Wiring Terminations: Match conductor materials and sizes indicated.

2.05 SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller.

B. Make completed controller available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least 7 days before inspections and tests are scheduled.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

C. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Provide fuses in fusible switches; refer to Section 16491 for product requirements.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Provide engraved plastic nameplates; refer to Section 16075 for product requirements and location.

F. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.16.2.

3.04 MANUFACTURER'S FIELD SERVICES

A. Provide the service of the manufacturer's field representative to prepare and start controllers.

3.05 ADJUSTING

A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.06 DEMONSTRATION

A. Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION

SECTION 16443

PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Distribution panelboards.

B. Branch circuit panelboards.

C. Load centers.

1.02 RELATED SECTIONS

A. Section 16075 - Electrical Identification.

1.03 REFERENCES

A. NECA (INST) - NECA Standard of Installation; National Electrical Contractors Association; latest edition.

B. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches; National Electrical Manufacturers Association; latest edition.

C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; latest edition.

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; latest edition.

E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; latest edition.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; latest edition.

G. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; latest edition.

H. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

E. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 MAINTENANCE MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

B. Furnish two of each panelboard key.

PART 2 PRODUCTS

2.01 DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 1, circuit breaker type.

B. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.

C. Minimum integrated short circuit rating: As indicated.

D. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.

E. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

F. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

G. Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower, with bimetal overload relay.

1. Coil operating voltage: 120 volts, 60 Hz.

2. Size as shown on Drawings.

3. Provide unit mounted control power transformer, RED indicating light in front cover.

H. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

I. Enclosure: NEMA PB 1 cabinet box; type and size as required.

J. Cabinet Front: Surface type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.02 BRANCH CIRCUIT PANELBOARDS

A. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

B. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

C. Minimum Integrated Short Circuit Rating: As indicated.

D. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles.

1. Type SWD for lighting circuits.

2. Class A ground fault interrupter circuit breakers where scheduled.

E. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

F. Enclosure: NEMA PB 1, Type 1.

G. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

H. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.03 LOAD CENTERS

A. Description: Circuit breaker load center, with bus ratings as indicated.

B. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical.

C. Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles.

1. Type SWD for lighting circuits.

2. Class A ground fault interrupter circuit breakers where indicated.

D. Enclosure: General Purpose.

E. Box: Flush type with door, and pull ring and latch on door. Finish in manufacturer's standard gray enamel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and the NECA Standard of Installation.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed or neatly handwritten circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates under the provisions of Section 16075.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

H. Ground and bond panelboard enclosure as required.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.

3.03 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 16510

INTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires for buildings, such as pump houses, to include:

1. Interior luminaires and accessories.

2. Ballasts.

3. Lamps.

4. Luminaire accessories.

1.02 REFERENCES

A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns; latest edition.

B. ANSI C82.1 - American National Standard Specifications for Fluorescent Lamp Ballasts; latest edition.

C. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); latest edition.

D. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; latest edition.

E. NFPA 70 - National Electrical Code; National Fire Protection Association.

F. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Instructions for each product.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 EXTRA MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

B. Furnish one replacement lamps for each lamp type.

C. Furnish one of each ballast type.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Furnish products as indicated in Schedule included on the Drawings.

B. Substitutions: See Section 01600 - Product Requirements.

2.02 BALLASTS AND CONTROL UNITS

A. Fluorescent Ballasts: ANSI C82.1, high power factor type electromagnetic ballast, suitable for lamps specified.

1. Voltage: 120 volts.

2. Certify fluorescent ballast design and construction by Certified Ballast Manufacturers, Inc.

B. High Intensity Discharge (HID) Ballasts: ANSI C82.4, mercury vapor lamp ballast, suitable for lamp specified.

1. Voltage: 120 volts.

2.03 LAMPS

A. Lamp Types: As specified for each luminaire.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall mounted luminaires at height as indicated on Drawings.

D. Install accessories furnished with each luminaire.

E. Connect luminaires to branch circuit outlets provided under Section 16138 using flexible conduit.

F. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

G. Bond products and metal accessories to branch circuit equipment grounding conductor.

H. Install specified lamps in each emergency lighting unit.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 01400.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.03 ADJUSTING

A. Aim and adjust luminaires as indicated.

3.04 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate luminaire operation for minimum of two hours.

3.06 PROTECTION

A. Re-lamp luminaires that have failed lamps at Substantial Completion.

END OF SECTION

SECTION 16520

EXTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires for buildings, such as pump houses, to include:

1. Exterior luminaires and accessories.

2. Ballasts.

3. Lamps.

4. Luminaire accessories.

1.02 REFERENCES

A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns; latest edition.

B. ANSI C82.1 - American National Standard Specifications for Fluorescent Lamp Ballasts; latest edition.

C. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); latest edition.

D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire which is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Maintenance Data: For each luminaire.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Electrical Components: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 EXTRA MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

B. Furnish one of each type and wattage lamp installed.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Furnish products as indicated in Schedule included on the Drawings.

B. Substitutions: See Section 01600 - Product Requirements.

2.02 BALLASTS

A. Fluorescent Ballasts: ANSI C82.1, high power factor type electromagnetic ballast, suitable for lamps specified.

1. Provide low-temperature ballast suitable for lamps specified.

2. Voltage: 120 volts.

3. Certify fluorescent ballast design and construction by Certified Ballast Manufacturers, Inc.

4. Substitutions: See Section 01600 - Product Requirements.

B. High Intensity Discharge (HID) Ballasts: ANSI C82.4, mercury vapor lamp ballast, suitable for lamp specified.

1. Voltage: 120 volts.

2.03 LAMPS

A. Lamp Types: As specified for each luminaire.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install luminaires as indicated on the drawings.

B. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install accessories furnished with each luminaire.

D. Connect luminaires to branch circuit outlets provided under Section 16138 using flexible conduit.

E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

F. Bond products and metal accessories to branch circuit equipment grounding conductor.

G. Install lamps in each luminaire.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.03 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution as recommended by the manufacturer.

3.04 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by the manufacturer.

C. Clean finishes and touch up damage.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate luminaire operation for minimum of two hours.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp luminaires which have failed lamps at Substantial Completion.

END OF SECTION

SECTION 16530

STREET LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Street lighting for City streets.

1.02 RELATED SECTIONS

A. Section 02312 - Trenching.

B. Section 16131 - Conduit.

C. Section 16123 - Building Wire and Cable.

D. Section 16138 - Boxes.

E. Section 16140 - Wiring Devices.

F. Section 16155 - Equipment Wiring.

1.03 REFERENCES

A. See appropriate sections of these specifications.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's installation instructions for equipment furnished under this and other sections.

B. Determine connection locations and requirements.

C. Coordinate all work on lighting system with Utah Power.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Street lights, including poles and luminaires, shall be as indicated on the drawings.

B. Disconnect Switches: As specified in applicable Sections and in individual equipment sections.

C. Wiring Devices: As specified in Section 16140.

D. Wire and Cable: As specified in Section 16123.

E. Boxes: As specified in Section 16138. Junction box lids to be marked “Saratoga Springs Electric”.

F. Concrete: As specified in Section 03300.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify location of street light with City Engineer.

B. Verify location and type of power source with Utah Power.

3.02 INSTALLATION - STREET LIGHTS

A. Construct concrete base for light pole; size and type to be according to manufacturer’s written instructions and recommendations. Anchor bolts shall be installed according to manufacturer’s template.

B. Install light poles and luminaires, with lamps, in accordance with manufacturer’s written instructions and recommendations. Poles shall be plumb and securely attached to the concrete base.

C. Install an electrical junction box near the base of the light pole, as required.

D. Install an electrical junction / fuse box four feet from power source, as indicated on the drawings and according Utah Power requirements. A fuse, of the appropriate type and size, shall be installed on the hot wire of the supply line, as required by Utah Power.

E. Install underground electrical supply line from fuse box to junction box at light pole, as indicated on the drawings and as directed by the City Inspector. Wire shall be direct burial, duplex cable of size indicated. Trenching shall be done as described in Section 02312. Cable to be installed with sand bedding and 24-inch cover. Trenches shall be backfilled and compacted to required densities, as directed by the City Inspector.

F. The neutral wire of the supply line shall not be cut. If it needs to be cut, the contractor shall supply and install a splice kit acceptable to Utah Power.

G. Connection to power source will be made by Utah Power. The contractor shall leave a 5-foot long pig-tail at the fuse box to be used for the connection. The contractor shall provide a trench from the fuse box to the source, as required by Utah Power.

H. Make electrical connection to light poles in accordance with equipment manufacturer's instructions and as indicated on the drawings.

J. All work shall be done in accordance with all appropriate electrical codes and with the requirements of Utah Power.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.04 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution as recommended by the manufacturer.

3.05 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean finishes and touch up damage.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp luminaires which have failed lamps at Substantial Completion.

END OF SECTION

SECTION 16540

OUTDOOR LIGHTING FOR COMMERCIAL AREAS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outdoor lighting for Commercial areas.

1.02 RELATED SECTIONS

A. Section 02312 - Trenching.

B. Section 16131 - Conduit.

C. Section 16123 - Building Wire and Cable.

D. Section 16138 - Boxes.

E. Section 16140 - Wiring Devices.

F. Section 16155 - Equipment Wiring.

1.03 REFERENCES

A. Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

B. See appropriate related sections of these specifications.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's installation instructions for equipment furnished under this and other sections.

B. Determine connection locations and requirements.

C. Coordinate all work on lighting systems with Utah Power.

D. Sequence electrical connections to coordinate with start-up of equipment.

1.07 LIGHTING REQUIREMENTS AND DESIGN STANDARDS

A. The purpose of lighting requirements is to require and set minimum standards for outdoor lighting to:

1. Provide for and control lighting in outdoor public places where public health, safety and welfare are potential concerns.

2. Protect drivers and pedestrians from the glare of non-vehicular light sources.

3. Protect neighbors and the night sky from nuisance glare and light trespass from improperly selected or poorly placed, aimed, applied, maintained or shielded light sources.

4. Promote energy-efficient lighting design and operation.

5. Protect and retain the intended visual character of the various venues of the City.

B. Applicability.

1. Uses that are proposed to operate during hours of darkness where there is public assembly and traverse, including but not limited to the following: commercial, industrial, parking lots, sales lots, recreational and institutional uses, and sign, billboard, architectural and landscape lighting applications.

2. The City may require lighting be incorporated for other uses, applications and locations, as it deems necessary.

3. The glare-control requirements herein contained apply to lighting in all uses, applications and locations.

C. Definitions.

1. Lighting definitions shall be as described in the IESNA Lighting Handbook.

2. The following definitions are selected from the Handbook for ready reference.
   a. Full Cutoff - attribute of a lighting fixture from which no light is emitted at or above a horizontal plane drawn through the bottom of the fixture, and no more than 10% of the lamp's intensity is emitted at or above an angle 10 degrees below that horizontal plane, at all lateral angles around the fixture.
   b. Cutoff - attribute of a lighting fixture from which no more than 2.5% of the lamp's intensity is emitted at a horizontal plane drawn through the bottom of the fixture or above, and no more than 10% of the lamp's intensity is emitted at or above an angle 10 degrees below that horizontal plane, at all lateral angles around the fixture.
   c. Fully Shielded – attribute of a lighting fixture provided with internal and/or external shields and louvers to prevent brightness from lamps, reflectors, refractors and lenses from causing glare at normal viewing angles.
   d. Glare - excessive brightness in the field of view that causes loss in visual performance or annoyance, so as to jeopardize health, safety or welfare.
   e. Light Trespass – light emitted by a lighting fixture or installation, which is cast beyond the boundaries of the property on which the lighting installation is sited.

D. Design Criteria.

1. Illumination Levels. Outdoor lighting, as allowed by the City, shall have intensities and uniformities and glare control in accordance with the current recommended practices of the IESNA as contained in the IESNA Lighting Handbook and applicable Recommended Practices, except as may otherwise be required by the City.
   a. The design calculations for outdoor lighting installations shall be in accordance with the Lighting Handbook. This is includes, but is not limited to, calculation methods and procedures, photometric classifications, and photometric testing procedures.
   b. Illuminance selection should be based on the usage of the area to be illuminated, the level of activity, and night-time security requirements.

2. Lighting Fixture Design.
    a. Fixtures shall be of a type and design appropriate to the lighting application and shall be aesthetically acceptable to the City.
    b. For the lighting of predominantly horizontal surfaces, such as, but not limited to parking areas, roadways, vehicular and pedestrian passage areas, merchandising and storage areas, automotive-fuel dispensing facilities, automotive sales areas, loading docks, cul-de-sacs, active and passive recreation areas, building entrances, sidewalks, bicycle and pedestrian paths, and site entrances, fixtures shall be aimed straight down and shall meet IESNA full-cutoff criteria.
        (1) Fixtures with an aggregate rated lamp lumen output per fixture that does not exceed the rated output of a standard 60-watt incandescent lamp, i.e., 1,000 lumens, are except from the requirements of this paragraph.
    c. For the lighting of predominantly non-horizontal surfaces, such as, but not limited to, facades, landscaping, signs, billboards, fountains, displays and statuary, fixtures shall be fully shielded and shall be installed and aimed so as to not project their output into the windows of neighboring residences, adjacent uses, past the object being illuminated, skyward or onto public roadways.
        (1) Fixtures with an aggregate rated lamp lumen output per fixture that does not exceed the rated output of a standard 60-watt incandescent lamp, i.e., 1,000 lumens, are except from the requirements of this paragraph.
    d. “Barn lights”, aka “dusk-to-dawn lights”, where visible from other properties, shall not be permitted unless fully shielded.

3. Control of Nuisance and Disabling Glare.
    a. All lighting shall be aimed, located, designed, fitted and maintained so as not to present a hazard to drivers and pedestrians by impairing their ability to safely traverse and so as not to create a nuisance by projecting or reflecting objectionable light onto a neighboring use or property.
    b. Floodlights and spotlights, where their use is specifically approved by the City, shall be so shielded, installed and aimed that they do not project their output into the windows of neighboring residences, adjacent uses, past the object being illuminated, skyward or onto a public roadway or pedestrian way.
    c. Parking facility and vehicular and pedestrian way lighting (except for safety and security applications and all-night business operations), for commercial, industrial and institutional uses shall be automatically extinguished no later than one hour after the close of business or facility operation. When safety or security lighting is proposed for after-hours illumination, it shall not be in excess of thirty-three (33) percent of the number of fixtures required or permitted for illumination during regular business hours.
    d. Illumination for signs, billboards, building facades and/or surrounding landscapes for decorative, advertising or aesthetic purposes is prohibited between 11:00 p.m. and dawn, except that such lighting situated on the premises for a commercial establishment may remain illuminated while the establishment is actually open for business, and until one hour after closing.
    e. Vegetation screens shall not be employed to serve as the primary means for controlling glare.
        (1) Glare control shall be achieved primarily through the use of such means as cutoff fixtures, shields and baffles, and appropriate application of fixture mounting height, wattage, aiming angle and fixture placement.
    f. The illumination projected from any property to a residential use shall at no time exceed 0.1 footcandle, measured line-of-sight from any point on the receiving property.
    g. The illumination projected from any property to a non-residential use shall at no time exceed 1.0 footcandle, measured line-of-sight from any point on the receiving property.
    h. Externally illuminated billboards and signs shall be lighted by fixtures mounted at the top of the billboard or sign and aimed downward. The fixtures shall be designed, shielded and aimed to limit the light output onto and not beyond the sign or billboard.
    i. Except for certain recreational lighting, fixtures meeting IESNA full-cutoff criteria shall not be mounted in excess of twenty (20) feet above finished grade. Fixtures not meeting IESNA full-cutoff criteria shall not be mounted in excess of sixteen (16) feet above finished grade.
    j. The United States flag and the state flag shall be permitted to be illuminated from dusk till dawn. All other flags shall not be illuminated past 11:00 p.m. Flag lighting sources shall not exceed 10,000 lumens per flagpole. The light source shall have a beam spread no greater than necessary to illuminate the flag.

k. Under-canopy lighting, for such applications as gas/service stations, hotel/theater marquees, fast-food/bank/drugstore drive-ups, shall be accomplished using flat-lens full-cutoff fixtures aimed straight down and shielded in such a manner that the lowest opaque edge of the fixture shall be below the light sources at all lateral angles.
    (1) The average illumination intensity in the area directly below the canopy shall not exceed 20 maintained footcandles and the maximum intensity shall not exceed 40 maintained footcandles.

l. The use of white strobe lighting for tall structures, such as smokestacks, chimneys, and radio/communications/television towers is prohibited during hours of darkness, except as specifically required by FAA.

1.08 OUTDOOR LIGHTING PLAN SUBMISSION

A. For land development applications where site lighting is required and is proposed, lighting plans shall be submitted to the City Engineer for review and approval, with the preliminary and final land development plan applications and conditional use applications; and shall contain the following:

1. A plan or plans of the site, complete, with all structures, parking spaces, building entrances, traffic areas (both vehicular and pedestrian), landscaping that might interfere with lighting, and adjacent uses that might be adversely impacted by the lighting.
    a. The lighting plan shall contain a layout of all proposed fixtures by location, orientation, aiming direction, mounting heights, and types.
    b. The submission shall include, in addition to proposed area lighting, all other exterior lighting, such as, architectural, building-entrance, landscape, flag, signs, etc.

2. A 10 ft x 10 ft illuminance grid (point-by-point) plot of maintained horizontal footcandles overlaid on the site plan, plotted out to 0.0 footcandles, which demonstrates compliance with the light trespass, intensity and uniformity requirements as set forth in the Lighting Handbook.
    a. When the scale of the plan makes a 10 ft x 10 ft grid plot illegible, a larger grid spacing may be used.

3. The lamp lumen ratings and types, maintenance (light-loss) factors and IES file nomenclature used in calculating the illuminance levels.

4. Description of the proposed equipment, including fixture catalog cuts, photometrics, glare reduction devices, lamps, on/off control devices, mounting heights, pole foundation details and mounting methods.

5. Landscaping plans shall contain lighting fixture locations and shall demonstrate that the site lighting and landscaping have been coordinated to minimize conflict between vegetation and intended light distribution, both initially and at vegetation maturity.

6. A visual-impact plan that demonstrates appropriate steps have been taken to mitigate the potential consequences of on-site and off-site glare and to retain the intended character of the City.
    a. This plan may require the inclusion of initial vertical footcandle values at specific off-site venues, such as, bedroom windows of adjacent residential uses.

7. Plan notes. The following notes shall appear on the Lighting Plan:
    a. Post-approval alterations to lighting plans or intended substitutions for approved lighting equipment shall be submitted to the City for review and approval.
    b. The City reserves the right to conduct post-installation inspections to verify compliance with the City's requirements and approved Lighting Plan commitments, and if deemed appropriate by the City, to require remedial action at no expense to the City.
    c. All exterior lighting shall meet IESNA full-cutoff criteria unless otherwise approved by the City.

PART 2 PRODUCTS

2.01 MATERIALS

A. Outdoor lighting, including poles, luminaries and appurtenant items, shall be as indicated on the construction drawings.

1. Outdoor lighting shall conform to all the Lighting Requirement and Design Standards described above.

2. Outdoor lighting shall be acceptable to the City Engineer.

3. Fixtures shall be of the cutoff type, in accordance with the candlepower distribution classification of the Lighting Handbook.
   a. The manufacturer of the fixtures shall provide certification of the cutoff classification based on photometric testing performed in accordance with the Lighting Handbook and the applicable testing procedures referenced therein.
   b. Fixtures which do not meet the strict definition for cutoff fixtures, yet employ advanced or alternative technology which causes the photometric performance to approach that of cutoff fixtures, may be approved by the City Engineer, on a case-by-case basis.
      (1) Such fixtures include, but are not limited to, period-style fixtures with refractive globes and internal cutoff reflectors.

B. Disconnect Switches: As specified in applicable Sections and in individual equipment sections.

C. Wiring Devices: As specified in Section 16140.

D. Wire and Cable: As specified in Section 16123.

E. Boxes: As specified in Section 16138. Junction box lids to be marked “Saratoga Springs Electric”.

F. Concrete: As specified in Section 03300.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify location of outdoor lighting items with the City Engineer.

B. Verify location and type of power source with Utah Power.

3.02 INSTALLATION - OUTDOOR LIGHTING

A. Mounting heights of lighting fixtures shall be as described in Paragraph 1.07 above.

B. Poles supporting outdoor lighting fixtures shall be installed as indicated on the construction drawings that have been reviewed and accepted by the City Engineer.

1. Poles for outdoor lighting fixtures for the illumination of parking areas and located directly behind parking spaces, or where they could be hit by snow plows, shall be placed a minimum of five (5) feet outside paved areas or tire stops, or placed on concrete pedestals at least thirty (30) inches high above the pavement, or suitably protected by other methods approved by the City Engineer.
2. Construct concrete bases for light poles, as indicated on the construction drawings; size and type to be according to manufacturer’s written instructions and recommendations. Anchor bolts shall be installed according to manufacturer’s template.

3.. Install light poles on bases, in accordance with manufacturer’s written instructions and commendations. Poles shall be plumb and securely attached to the concrete base.

C. Install pole mounted cutoff fixtures, with lamps, in accordance with manufacturer's written instructions and recommendations.

1. Fixtures for the illumination of horizontal areas shall be aimed straight down, as described in Paragraph 1.07 above.

2. Cutoff fixtures shall be mounted plumb and level in accordance with the intended application of their design.
   a. The photometric nadir or the fixture (zero degree vertical angle of the candlepower distribution) shall be oriented plumb and the vertical angle of 90 degrees above the nadir (horizontal) shall be oriented level.
   b. Cutoff fixtures shall not be installed in a canted or tilted position which permits candlepower distribution above the horizontal.

D. Install other types of lighting fixtures, with lamps, for other types of installations as indicated on the construction drawings, in accordance with manufacturer's written instructions and recommendations.

E. All electrical feeds for lighting poles shall be run underground. No overhead feeds will be permitted.

1. Electrical feeds shall be installed as indicated on the construction drawings.

2. Install an electrical junction box near the base of light poles, as required.

3. Install an electrical junction / fuse box four feet from power source, as indicated on the drawings and according Utah Power requirements. A fuse, of the appropriate type and size, shall be installed on the hot wire of the supply line, as required by Utah Power.

4. Install underground electrical supply line from fuse box to junction box at light pole, as indicated on the drawings and as directed by the City Inspector. Wire shall be direct burial, duplex cable of size indicated. Trenching shall be done as described in Section 02312. Cable to be installed with sand bedding and 24-inch cover. Trenches shall be backfilled and compacted to required densities, as directed by the City Inspector.

5. The neutral wire of the supply line shall not be cut. If it needs to be cut, the contractor shall supply and install a splice kit acceptable to Utah Power.

6. Connection to power source will be made by Utah Power. The contractor shall leave a 5-foot long pig-tail at the fuse box to be used for the connection. The contractor shall provide a trench from the fuse box to the source, as required by Utah Power.

7. Make electrical connection to light poles in accordance with equipment manufacturer's instructions and as indicated on the drawings.

8. All work shall be done in accordance with all appropriate electrical codes and with the requirements of Utah Power.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Operate each lighting fixture after installation and connection. Inspect for improper connections and operation.

3.04 ADJUSTING

A. Aim and adjust lighting fixtures to provide illumination levels and distribution as recommended by the manufacturer and as indicated on the construction plans.

3.05 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean finishes and touch up damage.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp lighting fixtures which have failed lamps at Substantial Completion.

END OF SECTION