

SP-097035
(New)



SPECIAL PROVISIONS

FOR

GENERAL ELECTRICAL REQUIREMENTS AND AUDIO SYSTEMS

Greene County
STP-E-3800(601)--8V-37

Effective Date
July 19, 2011

THE IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS AND GENERAL SUPPLEMENTAL SPECIFICATIONS.

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the general electrical requirements of these specifications and applies to all phases of the work specified, indicated on the drawings, or required to provide for complete installation of electrical systems for this project.

1.2 WARRANTIES

- A. The Contractor shall warrant all materials, workmanship and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those sections of the Project Manual. The Contractor shall repair or replace at no additional cost to the Contracting Authority any item which may become defective within the warranty period. Any manufacturers' warranties concerning any item installed will run to the benefit of the Contracting Authority. The Contractor agrees not to void or impair or to allow Sub-Contractors to void or impair any warranties regarding products or items installed as part of this project. The repair of faulty workmanship shall be considered to be included in the contract.

1.3 ALTERNATES

- A. Alternates, if required, shall be as described in the "Alternates" section of this Project Manual, as described on the proposal form, or as indicated on the drawings.

1.4 DEFINITIONS

- A. The following definitions shall apply throughout the contract documents:
 - 1. Code: The National Electrical Code and all applicable national, state and local codes
 - 2. Contractor: Any Contractor performing work required by the Contract Documents
 - 3. Electrical: All electrical work required by the contract documents
 - 4. Furnish: Supply and deliver to the site ready for installation
 - 5. Indicated: Noted, scheduled or specified
 - 6. Mechanical: All mechanical work required by the contract documents
 - 7. Provide: Furnish, install and connect, complete and ready for use
 - 8. Selected: Selected by the Engineer

1.5 SYMBOLS

- A. Items of equipment and materials are indicated on the drawings in accordance with the symbols on the plans.

1.6 ABBREVIATIONS

- A. The following abbreviations apply throughout the contract documents:

1. ASME: American Society of Mechanical Engineers
2. ASTM Specification: Standard specifications of the American Society for Testing Materials
3. CSA: Canadian Standards Association
4. ETL: Electrical Testing Laboratories
5. Factory Mutual: Factory Mutual Engineering Corporation
6. NEC: National Electrical Code, latest edition
7. NEMA: National Electrical Manufacturers Association
8. NFPA: National Fire Protection Association
9. Underwriters or UL: Underwriters Laboratories, Inc.

1.7 CODES AND STANDARDS

- A.** The work shall be performed by competent craftsmen skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted editions of the codes and standards listed below or the codes, standards and specifications published by the organizations listed below:

1. Safety and Health Regulations for Construction.
2. Occupational Safety and Health Standards (OSHA), National Consensus Standards and Established Federal Standards.
3. National Electrical Code (NEC), Latest Edition.
4. American National Standards Institute (ANSI).
5. National Electrical Manufacturer's Association (NEMA).
6. Institute of Electrical and Electronics Engineers (IEEE).
7. National Fire Protection Association (NFPA).
8. Insulated Power Cable Engineers Association (IPCEA).
9. American Society for Testing Materials (ASTM).
10. Life Safety Code (NFPA #101).
11. Underwriter's Laboratories, Inc. Standards (UL).
12. Independent Testing Laboratories (ITL).
13. Electrical Testing Laboratories (ETL).
14. National Electrical Safety Code (NESC).
15. Factory Mutual Engineering Corporation or other recognized national laboratories.
16. Uniform Building Code (UBC).
17. Electronic Industries Association (EIA).
18. Telecommunications Industry Association (TIA).
19. Building Industry Consulting Service International (BICSI).
20. State and local codes.

- B.** Where there is a conflict between the code and the contract documents, the code shall have precedence only when it is more stringent than the contract documents. Items that are allowed by the code but are less stringent than those specified shall not be substituted.

1.8 PERMITS

- A.** The Contractor shall become familiarized with all requirements regarding all permits, fees, etc., and shall comply with them. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at the Contractor's expense. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.9 MATERIALS AND EQUIPMENT MANUFACTURERS

- A.** The Contractor's options in selecting materials and equipment are limited by requirements of the contract documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects. Materials and equipment shall be provided in accordance with the following:
1. **Primary Design Products:** Primary design products are those products around which the project was designed in terms of capacity, performance, physical size and quality. Primary design products are indicated by use of a single manufacturer's name, model number or similar data on drawings or schedules or within the specifications. The Contractor shall provide primary design products unless substitutions are made in accordance with the following paragraphs.
 2. **Acceptable Equivalent Substitutions:** Acceptable equivalent substitutions are products of manufacturers other than those listed for the primary design products. Equivalent acceptable substitutions shall meet each of the following requirements:
 - a. The product shall be manufactured by one of the acceptable manufacturers listed in the Project Manual, drawings or addenda.
 - b. The product shall meet or exceed the requirements of the contract documents in terms of quality, performance, suitability, appearance and physical characteristics.
 - c. The Contractor providing the substitution shall bear the total cost of all changes due to substitutions. These costs may include additional compensation to the Engineer for redesign and evaluation services, increased cost of work by the Contracting Authority or other Contractors, and similar considerations.
 - d. **Performance Requirements.** Where the contract documents list performance requirements or describe a product or assembly generically, provide products that comply with the specific requirements indicated and that are recommended by the manufacturer for the respective application.
 - e. **Compliance with Standards, Code and Regulations:** Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including the standards, codes and regulations.
 3. Proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
 4. The Engineer shall be the sole and final judge as to the suitability of substitution items.

1.10 SUBMITTALS

- A.** Shop Drawings, Product Data and Samples:
1. When required by other sections of this Project Manual, the Contractor shall submit shop drawings, product data or samples to the Engineer for review. Unrequired submittals will not be reviewed. A completed copy of the transmittal form included with the Project Manual shall accompany each submittal. Submittals shall be numbered consecutively. Unless otherwise noted, submit a minimum of six copies of shop drawings and product data for review. A minimum of

four copies will be returned to the Contractor. Where samples are required, submit one sample of each required item.

- a. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for this project by the Contractor, or any manufacturer, supplier or distributor to illustrate some portion of the work.
 - b. Shop drawings shall be drawn to accurate scale and of adequate size to illustrate required details.
 - c. Product data are illustrations, standard schedules, performance charts, instruction brochures, diagrams and other information furnished by the Contractor to illustrate a material, product or system for some portion of the work.
 - d. Samples are physical examples furnished by the Contractor to illustrate materials, equipment or workmanship and to establish the standards by which the work will be performed.
2. All submittals shall clearly indicate proposed items, capacities, characteristics and details in conformance with contract documents. All equipment items shall be marked with the same item number as used on drawings or schedules. Capacities, dimensions and special features required shall be certified by the manufacturer.
 3. When required by other sections of this Project Manual, the Contractor shall submit a Specification Compliance Review consisting of a paragraph-by-paragraph review of the specifications and addenda with the following marked for each paragraph. Markings may be made in the margins of the original specification or addenda. Unless a deviation or exception is specifically noted in the Specification Compliance Review, it is assumed that the equipment, product, or material is in complete compliance with the contract documents. Submit Specification Compliance Review with shop drawings and product data.

 - a. "C": Comply with no exceptions.
 - b. "D": Comply with minor deviations. For each deviation, provide the reasons for the deviation and how the intent of the specification can be satisfied.
 - c. "E": Exception. Equipment, product, or material does not comply. For each exception, provide reasons for the exception, and suggest possible alternatives for the Contracting Authority's consideration.
 - d. "N/A": The paragraph does not apply to the proposed equipment, product, or material.
 4. The Engineer shall review or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only to determine conformance with the design concept of the work and the information given in the contract documents.
 5. The Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Engineer's review of shop drawings, product data or samples. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Engineer's review of those drawings.
 6. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Engineer. All such portions of the work shall be in accordance with reviewed submittals.
 7. Provide submittals in accordance with the schedule at the end of this section. See individual project manual sections for additional requirements.
 8. The successful contractor/supplier may, at their option, obtain DXF or AutoCad DWG electronic drawing files on CD for use in preparation of shop drawings. This information is available from Alvine and Associates upon written request.

The use of these drawing files is intended solely for the preparation of drawings as required by these contract documents. Any other use is strictly prohibited by Copyright law. The user of these electronic drawing files assumes full responsibility for their accuracy and scale.

B. Operation and Maintenance Manuals:

1. The Contractor shall prepare three operating and maintenance manuals for the equipment furnished. Manuals shall be submitted to the Engineer for review and distribution to the Contracting Authority not less than 30 days prior to substantial completion of the project. Manuals not meeting the following requirements may be rejected by the Engineer.
2. Each manual shall be assembled in a three-ring binder with hard cover and plastic finish. Binders shall not exceed 3 inches in thickness. Where more than one binder is required, the manuals shall be separated into a logical grouping, i.e., "Mechanical", "Electrical", "Maintenance", "Operation", "Parts", "Shop Drawings", etc. Where loose-leaf inserts are used, the sheets shall be reinforced to prevent tearing from continuous usage. Each binder shall have the following information clearly printed on its front cover:
 - a. Project name and address.
 - b. Portion of the work covered by each volume (if more than one volume in the set). Where more than one volume is required, label each volume as "Volume ___ of ___".
 - c. Name, address and telephone number of Contractor and all Sub-Contractors including night or emergency number.
3. Manual shall include, but shall not be limited to, the following:
 - a. A Complete Index. Contractor may submit the index to the Engineer for review prior to submittal of complete manuals if desired.
 - b. Names, Addresses and Telephone Numbers. This list shall include the manufacturer and local representative who stocks or furnishes repair parts for all items of equipment and shall be typed on a single page in front of the binder.
 - c. Start-Up, Operation and Shutdown Procedures. Provide a written description of procedures for start-up, operation and shutdown of each electrical item or system. This description shall include switches to operate, buttons to push, etc., in proper sequence, and location of switches and pushbuttons. Description shall include item references or labels used in the contract documents unless otherwise instructed in advance by the Contracting Authority.
 - d. Equipment Accessory Schedule. Upon completion of the work, the Contractor shall furnish the Contracting Authority with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and the manufacturer of all renewable items.
 - e. Manufacturer's Operation and Maintenance Manuals and Parts Lists.
 - f. One copy of all shop drawings and product data, clearly marked for each item furnished using the designation label specified or indicated on drawings.
 - g. All manufacturers' warranty information.
 - h. Normal Maintenance Schedule. Include a listing of work to be performed at various time intervals; i.e., 30, 90, 180 days and yearly.

1.11 OPERATING TRAINING

- A. Complete operating instructions for each system and item of equipment shall be provided to the Contracting Authority's designated personnel. Operation and maintenance manuals must be reviewed and accepted by the Engineer and provided to the Contracting Authority prior to operating training. Training shall be scheduled at the convenience of the Contracting Authority. A minimum of 2 hours of training shall be provided. Training shall include instructions on the following:
 - 1. Startup and shutdown procedures
 - 2. Periodic maintenance
 - 3. Safety
- B. In addition to the instructions required above, wherever possible the Contractor shall perform the operations being described in order to fully illustrate system operation.
- C. At the completion of training, the Contractor shall turn over to the Contracting Authority all required keys and special tools for installed equipment. Each key or tool shall be labeled with its use.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Unless otherwise specified, all materials and equipment shall be new, unused and undamaged. Materials and equipment shall be the current and standard designs of manufacturers regularly engaged in their production.

2.2 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details.

2.3 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in these specifications an article, device or piece of equipment is referred to in the singular number, such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

PART 3 - EXECUTION**3.1 TEMPORARY POWER AND LIGHTING**

- A. Provide temporary power and lighting throughout the construction period for the use by all trades, Contractors and Sub-Contractors. Temporary facilities shall be installed in compliance with applicable codes and in compliance with OSHA requirements.
- B. Cost of temporary power used during construction, including the cost of setting and removing temporary service, shall be paid by the Contractor. Where existing building elec-

trical system is used to provide temporary power and lighting, energy costs shall be paid by the Contracting Authority.

ELECTRICAL SUBMITTAL SCHEDULE

SECTION NUMBER	SECTION NAME	PRODUCT DATA	SHOP DRAWINGS	MAINTENANCE DATA	SAMPLES	WARRANTY	OTHER
Requirements vary. See specific section for applicability.							
16050	Basic Materials and Methods						✓
16060	Grounding and Bonding	✓					✓
16075	Electrical Identification						✓
16130	Raceways and Boxes	✓	✓				✓
16140	Wiring Devices	✓	✓	✓			
16521	Exterior Lighting	✓		✓			✓
16821	Audio Systems	✓	✓	✓			✓

END OF SECTION 16010

SECTION 16050**BASIC ELECTRICAL MATERIALS AND METHODS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electricity-metering components.
 - 3. Equipment connection.
 - 4. Concrete equipment bases.
 - 5. Electrical demolition.
 - 6. Cutting and patching for electrical construction.
 - 7. Touchup painting.
 - 8. Work in existing buildings.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.3 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

- D. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- F. Coordinate electrical testing of electrical items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Firestopping Materials: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dow Corning
 - 2. Hilti
 - 3. Metacaulk
 - 4. Specified Technologies, Inc.
 - 5. 3M Fire Protection Products
 - 6. Tremco Sealants and Coatings

2.2 SLEEVES FOR ELECTRICAL PENETRATIONS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.3 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and conduit.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of conduit. Include type and number required for material and size of raceway.
 - 2. Pressure Plates: Plastic. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16 inch diameter slotted holes at a maximum of 2 inches o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Expansion Anchors: Carbon-steel wedge or sleeve type.
- F. Toggle Bolts: All-steel springhead type.

2.5 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

- A. Meter Sockets: Comply with requirements of electrical power utility company.

2.6 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials:
 - 1. Forms: 3 1/2 inch minimum height, 3/4 inch chamfered edge at top of form.
 - 2. Reinforcement: 6 by 6 by 10/10 welded wire fabric with #4 reinforcing bars 12 inches on center each way for self-supporting pads.
- B. Concrete: 3000 psi, 28 day compressive strength.

2.7 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.8 HANDHOLES AND PULL BOXES

- A. Hand holes shall be 24 inches by 36 inches by 18 inches (nominal) UL Listed, divided - 3 compartment, ANSI Tier 15 rated, precast polymer concrete. Covers shall be precast polymer concrete, bolt-down, ANSI Tier 8 rated with skid-resistant surface and provided with "STREET LIGHTING" logos. Hand holes located in grass areas shall be forest green in color. Hand holes located in paved areas shall be a custom color, as selected by the Engineer.
- B. Pull boxes shall be UL Listed, 12 inches by inches by 12 inches or 11 inches by 18 inches by 12 inches (nominal, as indicated) UL Listed, ANSI Tier 15 rated, precast polymer concrete. Covers shall be precast polymer concrete, bolt-down, ANSI Tier 8 rated with skid-resistant surface and provided with "STREET LIGHTING" logos.

2.9 SPLICES AND TAPS

- A.** Splices within luminaires shall be made with wire nuts.
- B.** Splices and taps at underground or wet locations, such as in hand holes, shall be made with UL Listed, insulated, submersible, multiple tap connectors with heavy duty EPDM covers and screw caps. Openings in the splicing devices shall be closed when conductor installation is completed. Connectors shall have a minimum of three ports and shall be suitable for terminating the conductor sizes present.
- C.** Splices and taps at dry, above-grade locations (other than within luminaires) shall be made with UL Listed, insulated, multiple tap connectors with screw caps. Openings in the splicing devices shall be closed when conductor installation is completed. Connectors shall have a minimum of four ports and shall be suitable for terminating the conductor sizes present.
- D.** Split bolt connectors may only be used for joining equipment grounding conductors to grounding electrode conductors in hand holes.
- E.** Splices shall NOT be made with fuse holders.

2.10 FUSES AND FUSE HOLDERS

- A.** Fuses shall be installed in the hand hole for each luminaire. Fuses shall be Class CC (13/32 inches by 1 1/2 inches) rejection type, and shall be of the type and size as recommended by the luminaire manufacturer.
- B.** Fuse holders shall be two-pole, water-resistant. The terminals shall be suitable for terminating the conductors used. Insulating boots shall be provided for both the line and load sides of the fuse holders.
- C.** The line side of each fuse holder shall be provided with permanent markers identifying the circuit number to which the fuse holder is connected.

2.11 ELECTRICAL CONTROL PEDESTAL

- A.** The electrical control pedestal shall be as manufactured by Millbank, Meyers, or Pacific Utilities.
- B.** The pedestal shall be suitable for operation on a 120/208 volt, 300 amp, three-phase, four-wire system. The pedestal shall be rated for 42 KAIC capacity.
- C.** The pedestal shall be NEMA 3R rated and have a UL 508 label.
- D.** The pedestal shall be aluminum with have an industrial-grade powder coat factory finish. Color shall be custom, as selected by Engineer.
- E.** Install the pedestal on the manufacturer's pedestal mounting base embedded in concrete, as indicated.
- F.** Provide a 300 amp, 42 space, unswitched panelboard (PA) with 300 amp main circuit breaker. Provide branch circuit breakers as indicated on the schedules. The neutral bus of the panelboard shall be bonded to the grounding system.

- G. Provide a typed schedule for the panel.
- H. Provide three twelve-pole, NEMA rated, 30 amp, electrically held lighting contactors with 120 volt operating coils for controlling the lighting circuits.
- I. Provide two twelve-pole, NEMA rated, 30 amp, electrically held contactors with 120 volt operating coils for controlling the receptacle circuits.
- J. Provide an internally-mounted NEMA twist-lock photo cell, with window and glare shield. The photo cell shall turn on at 1.5 foot-candles, and shall have a turn on/turn off ratio of 1:3. The photo cell shall be electronic with silicon sensor and have a rated life of at least 5000 operations at rated load.
- K. Provide a mechanical time clock for controlling one of the lighting contactors (in conjunction with the photo cell) and both receptacle contactors.
- L. Provide internally mounted Hand-Off-Auto control switches for controlling the lighting and receptacle contactors. In Hand, the switch shall connect control power directly to the contactor coil. In Auto, control power shall be routed through the photo cell (and time clock, where applicable) to the contactor coil. The control switches shall be 30.5 mm with gloved hand operator.
- M. Provide internally mounted indicator lights to indicate when each contactor coil is energized. The indicator lights shall be 30.5 mm, 120 vac, of the press-to-test transformer type and shall be provided with LED light sources. Color shall be red.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Unless otherwise noted, measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to raceways and piping systems installed at a required slope.
- F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- G. Laying Out work:
 - 1. Carefully lay out all work in advance of installation using data and measurements from the site, the appropriate civil and structural drawings, and shop drawings.

Confirm code required clearances. Do not infringe upon space required for operation, maintenance, or clearance for items installed by other contractors.

2. Prior to installation of any work, make certain the location does not conflict with other items in or near the same location. If the layouts so prepared indicate that the required conditions cannot be met in the space provided, inform the Engineer prior to installation and request clarification.
3. Failure to properly coordinate and lay out work will require correction by the Contractor at the Contractor's expense.

H. Data and Measurements: Data given herein and on the drawings is as accurate as could be secured; absolute accuracy is not guaranteed. Obtain exact locations, measurements, levels, etc., at the site and adapt work to actual conditions. Examine the general construction, mechanical, electrical, and other applicable drawings and the specifications. Plans and specifications are available for examination at the office of the Engineer. Utilize only civil drawings, structural drawings, and site measurements in calculations. Electrical drawings are diagrammatic or schematic.

I. Position of Outlets:

1. Locate all outlets and devices mounted on finished surfaces with regard to paneling, furring, trim, etc. Install outlets and devices with vertical edges of plates plumb. Install boxes or plaster rings such that the front edge extends to the finished surface of the wall, ceiling or floor without projecting beyond the surface.
2. Install receptacles, switches, etc., on wood trim, cases, or other fixtures symmetrically and, where necessary, install with the long dimension of the plate horizontal.
3. Coordinate locations of outlets and devices with other contractors so as not to destroy the aesthetic effect of the surface in which the outlets and devices are mounted. Coordinate the locations of electrical items with work furnished by other trades to avoid interference.
4. Install outlets at the heights indicated below unless otherwise noted. All heights of outlets are measured from finished floor to centerline of device. Adjust heights as necessary to clear wall-mounted cabinets, fin tube convectors, unit heaters, etc. Mounting heights shall be in compliance with ADA requirements. When devices are installed in masonry walls, adjust mounting heights to correspond to block coursing. Do not mount outlets below 15 inches or switches above 46 inches.
 - a. Receptacle outlets (general): 16 inches.
5. The mounting heights of disconnect switches, circuit breakers, motor controllers, pushbutton stations and other similar devices and equipment may vary depending upon location and whether individually or group mounted. For convenience and safety, mount equipment with the center of operating levers, handles or buttons no more than 72 inches above the finished floor. Locate individual devices or pieces of equipment, unless otherwise specified, so the operating handle, lever or button is located approximately 5 feet above finished floor. Coordinate heights of all electrical items with work furnished by other trades to avoid interferences.
6. Improperly located devices or outlets shall be relocated by the Contractor at the Contractor's expense including necessary patching.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A.** Coordinate sleeve selection and application with selection and application of firestopping.

- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Space sleeves a minimum of three sleeve diameters on center, unless otherwise noted.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceways or cable unless sleeve seal is to be installed.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal with firestop materials.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Underground, Exterior-Wall Penetrations: Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.5 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.

- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four.

3.6 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Install 1/4 inch diameter or larger threaded steel hanger rods, unless otherwise indicated.
- F. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1 1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- G. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- H. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- I. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- J. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 7. Light Steel: Sheet-metal screws.
 - 8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.7 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.8 EQUIPMENT CONNECTION

- A. General:
 - 1. Provide final power and control connections for all equipment furnished under other Divisions of this specification and for all Contracting Authority-furnished equipment.
 - 2. Verify all control wiring requirements with manufacturer certified shop drawings for each piece of equipment or control system and install accordingly. Install control wiring in conduit.

3.9 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Dowel to structural slab.

3.10 EXCAVATION

- A. General: Perform all excavation of every description and of whatever substances encountered, to the depths required or indicated on the drawings, in accordance with OSHA. During excavation, deposit material suitable for backfill in an orderly manner a sufficient distance from the excavation banks to avoid overloading and to prevent slides or cave-ins. Dispose of material unsuitable for backfill as directed by the Engineer. Grade as necessary to prevent surface water from flowing into trenches or other excavations, and remove any water accumulating therein by pumping or by other acceptable method. Fill any excess excavation below the levels indicated for structures or raceways with sand, gravel or concrete.
- B. Unsuitable Material: Where the bottom of the trench is found to be unstable or to include ashes, cinders, any types of refuse, vegetable or other organic material, or large pieces or fragments of inorganic material, which in the judgement of the Engineer should be removed, excavate and remove such unsuitable material to a minimum depth of 12 inches below the conduit. Backfill the trench with selected bedding material and compact to provide uniform and continuous bearing for the conduit. Dispose of the unsuitable material.

3.11 BACKFILL

- A. General: Do not backfill until all required inspections are made and tests are performed for the specific utility. Backfill with the excavated materials specified for backfilling, consisting of earth, loam, sandy clay, sand and gravel or other materials, free from large clods of earth or stones. Do not use broken concrete as backfill materials. Do not backfill in freezing weather or with frozen material. Adjust the moisture content of the backfill material if required for proper compaction. Reopen any trenches improperly backfilled, or where settlement occurs, to the depth required for proper compaction, refill and compact to specified density. Compact all backfill for structures to the specified density.
- B. During the backfilling of each exterior underground conduit system, install continuous underground type plastic line markers. Locate directly over the buried conduit at 12 inches

to 18 inches below finished grade. Where multiple small conduits are buried in common trenches and do not exceed an overall trench width of 16 inches, install a single line marker.

- C. Deposit suitable backfill material around the conduit in 6 inch layers and thoroughly compact by hand, machine tamper, or other suitable equipment. Backfill to at least 90 percent of maximum density at optimum moisture content determined by ASTM D698 until the conduit has a minimum cover of 2 feet. The moisture content of the soil at time of compaction shall be not more than 3 percent above or 3 percent below the optimum. Be careful not to disturb the conduit. Carry backfilling on simultaneously on both sides of the conduit to eliminate the possibility of lateral displacement.
- D. Return surface to original condition. Prepare backfilled areas to receive seeding.

3.12 UTILITY COMPANY SERVICE

- A. Verify all details related to the electrical service and metering with the utility company. The payment of all utility company fees shall be included in this contract. Payment shall be made within 30 days of award of contract.
- B. The utility company will connect the secondary cables to the transformer. The secondary conduit(s), secondary cables, and terminations and conduits, are the responsibility of the Electrical Contractor.

3.13 WORK IN EXISTING BUILDINGS

- A. General: Execute work in the existing building, indicated on the drawings or specified herein, with a minimum amount of interference with the normal activities of the occupants of the building. Schedule work in advance with the Contracting Authority and proceed only with the Contracting Authority's written approval.
- B. Utilities: Do not interrupt utilities without the Contracting Authority's prior written approval regarding the time and duration of such interruptions. Do not disconnect utilities to existing facilities until new or temporary facilities are installed except for short periods of interruption which are necessary for the performance of the new work and which are approved by the Contracting Authority. Storm water may be temporarily diverted to surface drainage provided such drainage is arranged to prevent flooding of structures, basements and excavations for construction.
- C. Welding: Notify the Contracting Authority before starting welding or cutting. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc. Stop operations involving welding or cutting with an open flame or arc not less than one hour before leaving the premises.
- D. Noisy Operations: Schedule noisy operations, such as those involving use of air hammers, etc., in demolition or cutting of openings, with the Contracting Authority.
- E. Occupancy: The Contracting Authority will continue to occupy the building and carry on normal activity. Protect the occupied areas from dust, smoke, etc., by a method reviewed by the Engineer.
- F. Contracting Authority's Right to Direct Work: The Contracting Authority shall have the right to direct the places of beginning work, its prosecution, and the manner in which all work under this contract is to be conducted, insofar as may be necessary to secure the safe and proper progress and quality of the work.

- G. Existing Conduits or Electrical Equipment: Remove or relocate, as required, or as directed by the Engineer, existing conduit or electrical equipment which would interfere with the proper installation of new work. Modify existing work in conformance with these specifications. Use the same materials as for new work unless otherwise specified.

3.14 DEMOLITION AND REMODEL

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- F. Remove all existing lights, receptacles, switches, etc., indicated on plans or which are not indicated but must be removed to accommodate demolition or new remodeling.
- G. In areas which are remodeled, replace existing wire with new wire. No existing wire is permitted to remain unless noted. Existing concealed conduit and boxes may be reused.
- H. Verify existing conditions in field prior to bid date.

3.15 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.16 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 1. Sleeves.
 2. Firestopping.
 3. Supporting devices for electrical components.
 4. Electricity-metering components.
 5. Concrete bases.
 6. Electrical demolition.
 7. Cutting and patching for electrical construction.
 8. Touchup painting.

3.17 CLEANING AND PROTECTION

- A.** On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

- B.** Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 16050

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 SUBMITTALS

- A. Product Data: For the following:

1. Ground rods.
2. Ground bars.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."
- B. Equipment Grounding Conductors: Insulated; green-colored insulation for #6 AWG and smaller; with green-colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points for sizes larger than #6 AWG.
- C. Grounding Electrode Conductors: Bare, tinned, stranded, unless otherwise indicated.
- D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- E. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

2.2 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors at interior locations. Use bare copper equipment grounding conductors at exterior locations.
- C. Exothermic-Welded Connections or High-Pressure Compression Connections: Use for underground connections.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Underground Grounding Conductors: Use copper conductor, No. 6AWG minimum.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all power raceways.
- C. Wiring Devices: Install an insulated bonding jumper from the ground terminal of each wiring device to its respective outlet box.
- D. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

- A. Ground Rods: At the electrical control pedestal, install two rods spaced at least 20 feet from each other. Install single rod at other locations.
 - 1. Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds. Make connections without exposing steel or damaging copper coating.
- B. Grounding Electrode Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- C. Establish one neutral-to-ground connection point within each piece of service equipment. Provide a removable jumper between the neutral and ground conductors.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing or at a nonmetallic housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

- A. Test the completed grounding system at the service ground bar. Do not energize service if test indicates resistance greater than 5 ohms, unless approved by the Engineer.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION 16060

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceways.
 - 2. Identification for conductors.
 - 3. Underground warning tape.
 - 4. Warning labels and signs.
 - 5. Equipment identification labels.
 - 6. Miscellaneous identification products.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 3/4 to 2 inches wide.
- B. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with white letters on black face unless otherwise indicated..
 - 2. Self-adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker.
- F. Conductor Color Coding: Use the following colors:
 - 1. 208/120-V conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green or Blue.
 - 2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 6 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 3/4 inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
- G. Conductor Labeling: Tag each conductor with its corresponding circuit number in panels, control cabinets, hand holes, pole bases, pull boxes, and all other accessible locations.
- H. Equipment Identification Labels.
 - 1. Engraved Plastic Laminate: Unless otherwise indicated, provide a single line of text with 3/8 inch high lettering on 1 inch label; where two lines of text are required, use labels 1 3/4 inches high.
 - 2. Install on each unit of equipment unless units are specified with their own self-explanatory identification.
 - 3. Apply labels for each of the following categories of equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Disconnect switches.
 - d. Enclosed circuit breakers.
 - e. Contactors.
 - f. Control devices.

END OF SECTION 16075

SECTION 16120
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600V and less.
 - 2. Connectors, splices, and terminations rated 600V and less.
- B. Related sections include the following:
 - 1. Section 16075, Electrical Identification, for conductor color-coding.

1.2 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.4 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Conductor and Insulation Applications" Article.
- B. Conductor Insulation Material: Comply with NEMA WC 70.
- C. Conductor Material: Copper.
- D. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

2.2 CONNECTORS AND SPLICES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THWN, in raceway.
- B. Feeders: Type THHN/THWN or XHHW in raceway.
- C. Branch Circuits: Type THHN/THWN, in raceway; #12 AWG minimum. Provide a dedicated neutral for each branch circuit required a neutral.
- D. Class 1 Control Circuits: Type THHN/THWN, in raceway; #14 AWG minimum.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Neatly arrange wiring inside boxes, equipment, and panelboards.
- E. Provide the required quantities of wires for all circuits.
- F. Support cables according to Section 16050, Basic Electrical Materials and Methods.
- G. Identify wires and cables according to Section 16075, Electrical Identification.

3.4 CONNECTIONS

- A. Conductor Splices: Keep to minimum.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

- C. Use splice and tap connectors compatible with conductor material.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 16120

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring and telecommunications cabling pathways.
- B. Related Sections include the following:
 - 1. Section 16050, Basic Electrical Materials and Methods, for sleeves, supports, anchors, and identification products.
 - 2. Section 16140, Wiring Devices, for devices installed in boxes and for floor-box service fittings.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access. Do not install exposed raceways on floor surfaces. Do not support from floor surfaces in a manner which impedes access to spaces or equipment or which creates a tripping hazard.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- B. Fittings: NEMA FB 1; compatible with conduit and tubing materials.
- C. Bushings: Thermosetting phenolic.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- B. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- C. Sheet Metal Pull and Junction Boxes: Galvanized sheet metal with a removable cover on the largest side of the box. Include cable supports if any dimension of the box is greater than 48 inches.
- D. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.4 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 - 1. Exposed: EMT.
 - 2. Concealed: RNC
 - 3. Underground: RNC.
 - 4. Boxes and Enclosures: NEMA 250, Type 3R.
- B. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Boxes and Enclosures: NEMA 250, Type 1.

- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Provide insulated bushings on box connectors 1 inch and larger.

3.2 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Securely fasten each component to the surface on which it is mounted.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Section 16050, Basic Electrical Materials and Methods.
- E. Install temporary closures to prevent foreign matter from entering raceways.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Run concealed raceways parallel and perpendicular to structural members of the building.
- H. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible. In finished areas with exposed structure, install raceways tight to deck of roof or floor above.
 - 1. Run parallel or banked raceways together on common supports.
- I. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Provide expansion joints for conduits crossing building expansion joints and for conduits connected to two separate structures.
- J. Tighten set screws of threadless fittings with suitable tools.
- K. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

- M.** Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces and building exterior walls.
 - 2. Where otherwise required by NFPA 70.
- N.** Exterior Branch Circuits: Route conduits adjacent to curbs. Push or directional bore conduits beneath paved areas; otherwise, sawcut and remove pavement. Replace removed pavement to match existing.

3.3 FIRESTOPPING

- A.** Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 ELECTRICAL SERVICE

- A.** Provide a secondary duct bank consisting of PVC 80 conduits sized as indicated on drawings. Provide elbows at the transformer pad and beneath service equipment, as required.

3.5 PROTECTION

- A.** Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

- A.** After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Duplex receptacles, ground-fault circuit interrupters.
 - 2. Device wall plates.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.

1.3 SUBMITTALS

- A. Product Data: for each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Manufacturers and catalog numbers are scheduled to establish the standard of quality required. Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. Cooper Wiring Devices; a division of Cooper Industries, Inc.
 - b. Hubbell, Inc.; Wiring Devices-Kellems.
 - c. Pass & Seymour/LeGrand; Wiring Devices and Accessories.

2.2 RECEPTACLES

- A. Straight-Blade Receptacles: Duplex, 20A, 125V, side- and back-wired. Receptacles at exterior locations shall be GFCI, weather-resistant

2.3 WALL PLATES

- A.** Single and combination types match corresponding wiring devices.
 - 1.** Plate-Securing Screws: Metal with head color to match plate finish.
 - 2.** Material for Finished Spaces: Match existing.
 - 3.** Weatherproof Plates: Metal with gasket and hinged cover, weatherproof with cord inserted, Hubbell WP8M Series or WP26M Series, suitable for the device installed. Provide a factory finish to match pole color.

2.4 FINISHES

- A.** Color: Gray, at pole locations. Match existing color for interior locations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A.** Install devices and assemblies plumb and secure.

3.2 IDENTIFICATION

- A.** Comply with Section 16075, Electrical Identification.

3.3 CONNECTIONS

- A.** Connect wiring device grounding terminal to branch-circuit equipment grounding conductor and to outlet box with grounding jumper.
- B.** Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A.** Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B.** Test GFCI operation according to manufacturer's written instructions.
- C.** Replace damaged or defective components.

3.5 CLEANING

- A.** Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 16140

SECTION 16521
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

1.2 DEFINITIONS

- A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.
- B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
1. Materials and dimensions of luminaires and poles.
 2. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 3. High-intensity-discharge luminaire ballasts.
- B. Operation and Maintenance Data: For lighting units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING OF POLES

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Contracting Authority of other rights Contracting Authority may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, signed by manufacturer and Installer agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies Contracting Authority may have under requirements of the Contract Documents.
 - 1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.
 - 2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.
 - 3. Warranty Period: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Schedule or as otherwise indicated on drawings.

2.2 POLES

- A. Description:
 - 1. The extruded pole shaft shall be configured utilizing a four-sided dovetail track system.
 - 2. The exterior of the profile shall be constructed for modular accessory attachments which can be moved or changed after initial installation.
 - 3. The interior of the pole shall have five independent and separate wiring raceways for initial assembly and post installation wiring flexibility.
- B. Design:
 - 1. The pole shall conform to the requirements of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, either 1994 or 2001 edition (as specified by the customer) by The American Association of State Highway and Transportation Officials for a basic wind speed as specified supporting luminaires and other accessories as specified by the customer.
- C. Materials:
 - 1. Shaft - The shaft shall be constructed of extruded tube of 6061-T6 aluminum in accordance with the requirements of ASTM B221-02. The pole shall be of sufficient nominal thickness to meet the design requirements without use of internal reinforcing sleeve. No longitudinal shaft welds shall be allowed.

2. Structural Decorative Base - The base shall be a one-piece cast decorative structural base of aluminum alloy 356 per ASTM B26 or B108. The base shall be joined to the shaft by means of a complete circumferential weld. The base shall have a cast aluminum access door fastened to the base with tamper resistant screws. The base shall have provisions for grounding by the use of a lug (with drilled and tapped hole) cast to the inside of the structural base opposite to and accessible through the access door.

D. Welding:

1. Welding shall be done by the inert gas shielded metal arc method with consumable electrode. Aluminum alloy 4043 electrode shall be used. Welding shall be in accordance the American Welding Society AWS Specification D1.2, Structural Welding Code - Aluminum.

E. Anchorage:

1. Four steel anchor bolts shall be supplied with each lighting pole. The bolt size and length shall be in accordance the AASHTO Specification for the loads imposed by the poles. The anchor bolt material shall meet the requirements of AASHTO M314-90 Grade 55. Bolts shall be hot dipped galvanized per ASTM A153 at the threaded end for at least 10 inches. For each bolt a heavy hex nut per ASTM A563 grade DH or 2H and washer shall be supplied. The nut and washer shall be fully galvanized per ASTM A153 or ASTM B695.

F. Miscellaneous Hardware:

1. All nuts, bolts, and washers used in the assembly of the pole shall be AISI type 300 series stainless steel per ASTM A193 Class 1 Grade B8 except for anchorage hardware.

G. Type P1 Pole:

1. Decorative extruded aluminum pole with four self-contained tracks for mounting luminaire, banners, flag poles, speaker system, and video system. 17 inch base, 14 feet height, 5.25 inch diameter fluted, 0.25 inch thick wall, round base, 3 inch by 3 inch tenon, anchor bolts, galvanized steel, powder coat paint finish, dark green.

H. Type P2 Pole:

1. Decorative extruded aluminum pole with four self-contained tracks for mounting luminaire, banners, flag poles, speaker system, and video system. 15 inch base, 10.5 feet height, 5.25 inch diameter fluted, 0.25 inch thick wall, round base, 3 inch by 3 inch tenon, anchor bolts, galvanized steel, powder coat paint finish, dark green.

I. Type P3 Pole:

1. Decorative aluminum pole, 17 inch base, 14 feet height, 5 inch diameter fluted, 0.25 inch thick wall, 17 inch round base, 3 inch by 3 inch tenon, anchor bolts, galvanized steel, powder coat paint finish, bronze.

J. Type P4 Pole:

1. Decorative aluminum pole, 17 inch base, 12 feet height, 5 inch diameter fluted, 0.25 inch thick wall, 17 inch round base, 3 inch by 3 inch tenon, anchor bolts, galvanized steel, powder coat paint finish, bronze.

2.3 BANNER ARMS

A. Description:

1. The banner arms shall consist of an aluminum 6061-T6 schedule 80 pipe or aluminum extrusion, an aluminum channel mounting plate, and a cast aluminum coupling.

B. Construction:

1. The banner arm shall be bolted to a welded mounting plate through a cast aluminum coupling with a stainless steel latch-pin.
2. The banner arm shall attach to the track system of the pole.

C. Materials:

1. The finial shall be cast aluminum, produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95 and welded to the end of the banner arm.
The banner arm
2. Mounting plate shall be aluminum, ASTM 356 alloy, heat treated to a T6 temper. All hardware shall be stainless steel.
3. Dark green powder coat paint finish.

D. Dimensions:

1. The banner arms shall be 1.5 inch outside diameter and 24 inches long.

2.4 CROSS ARMS

A. Construction:

1. The crossarms shall be one-piece construction. The arms shall be welded to a center spool. All welding shall be per ANSI/AWS D1.2-90.

B. Materials:

1. The arms, finials, and center spool tenons, shall be heavy wall, cast aluminum produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95. The center spool and wall bracket mounting plate shall be aluminum, ASTM 6061 alloy, heat treated to a T6 temper. All hardware shall be stainless steel. All exterior hardware shall be tamper resistant.
2. Dark green powder coat paint finish.

C. Installation:

1. The crossarms shall slip-fit a post top tenon and attach with socket set screws. The center finial shall be removable. Crossarms shall have 3 inch outside diameter tenons for luminaire mounting.

2.5 FLAG POLE HOLDERS

- A. Construction:
1. The flagpole holders shall be one piece construction. The holders shall consist of a piece of aluminum tubing welded at 45 degrees to a mounting plate. All welding shall be per ANSI/AWS D1.2-90.
 2. The flagpole holders shall be aluminum, ASTM 6061 alloy, heat treated to a T6 temper. All hardware shall be stainless steel.
 3. The flagpole holders shall attach to the track system of the pole.
 4. Holders shall be sized to accommodate 1 inch outside diameter flag poles.
 5. Dark green powder coat paint finish.

2.6 SPEAKER MOUNTING PLATES

- A. The speaker mounting plate shall be aluminum, ASTM 356 alloy, heat treated to a T6 temper.
- B. All hardware shall be stainless steel. Mounting plate shall mount to pole via track system which can be moved or changed after initial installation.

2.7 LUMINAIRES

- A. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- B. Metal Parts: Free from burrs, sharp corners, and edges.
- C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use.
- D. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.
- E. Optical System: The optical assembly shall consist of a precisely molded thermal resistant borosilicate glass reflector and refractor. The upper portion of this system shall incorporate a series of reflecting prisms that redirect over 50% of the upward light into the controlling refractor while allowing a soft upright component to define the traditional acorn shape. The lower portion shall utilize precisely molded refracting prisms to control the distribution of light to maximize utilization and uniformity. The very top of this assembly shall consist of a removable prismatic glass cover with decorative finial for tool-less entry into the lamp chamber.
- F. Luminaire Housing: The luminaire housing shall consist of cast of aluminum and provide an enclosure for the plug-in electrical module. The nickel plated lamp grip socket and three station incoming line terminal block shall be prewired to a five conductor receptacle for ease in connection of the electrical module. The slipfitter shall accept a 3 inch by 2 7/8 inch to 3 1/8 inch outside diameter tenon.
- G. Luminaire Housing/Door: Cast of aluminum, the housing / door shall be removable without the use of tools and be retained by a nonconductive lanyard, attached to the door and to the housing. For units with a N.E.M.A. twist lock photocell receptacle, the door shall contain an acrylic "window" to allow light to reach the cell.

- H. Electrical Module: The ballast components shall be mounted on a steel plate that is removable without the use of tools. A matching five conductor plug shall connect to the receptacle in the luminaire housing to complete the wiring. Where a starting aid is required, it shall be provided with a separate plug-in connector and be replaceable without the use of tools. For photoelectric operation, the electrical module shall be provided with a N.E.M.A. twist lock photocell receptacle.
- I. Type F1 Luminaire: Pulse start metal halide, mogul base, multivolt wired for 208V only. UL Listed, dark green, asymmetric, Type III, with gold spike finial, gold band and gold ribs.
- J. Type F2 Luminaire: Pulse start metal halide, medium base, multivolt wired for 208V only. UL Listed, dark green, asymmetric, Type III, with gold spike finial, gold band and gold ribs.
- K. Type F3 Luminaire: Pulse start metal halide, mogul base, multivolt factory wired for 120V only. UL Listed, bronze, asymmetric, Type IV, with bronze spike finial, and NEMA twistlock photocontrol receptacle.
- L. Type F4 Luminaire: Pulse start metal halide, medium base, multivolt factory wired for 120V only. UL Listed, bronze, symmetric, Type V, with bronze spike finial, and NEMA twistlock photocontrol receptacle.
- M. Finish: The luminaire shall be finished with polyester powder paint to insure maximum durability.
- N. UL: The luminaire shall be UL listed as suitable for wet locations at a maximum of 104 degrees F ambient temperature.
- O. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage auto-transformer for 100W and 150W lamps, regulating high-power-factor type for other lamps, unless otherwise indicated.
 - 1. Single-Lamp Ballasts: Minimum starting temperature of minus 40°F.
 - 2. Open-circuit operation will not reduce average life.
 - 3. Noise: Uniformly quiet operation, with a noise rating of B or better.
- P. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.
 - 1. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.8 LUMINAIRE SUPPORT COMPONENTS

- A. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

1. Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Will not cause galvanic action at contact points.
 2. Mountings: Correctly position luminaire to provide indicated light distribution.
 3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
 4. Anchor-Bolt Template: Plywood or steel.
- D. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
- E. Aluminum Poles: Fabricated from seamless, extruded structural tube complying with ASTM B 429, 6063-T6 alloy with access handhole in pole wall.
 1. Grounding Provisions for Metal Pole/Support Structure: Welded 1/2-inch threaded lug, accessible through handhole and listed for copper conductor connection.
- F. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Provide pole finishes and colors as indicated on the drawings or in the specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Concrete Foundations:
 1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.
 2. Finish for Parts Exposed to View: Trowel and rub smooth.
- B. Install poles as follows:
 1. Use web fabric slings (not chain or cable) to raise and set poles.
 2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 3. Secure poles level, plumb, and square.

- 4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.
- C. Luminaire Attachment: Fasten to indicated structural supports.
- D. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.
- E. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Ground metal poles/support structures according to Section 16060, Grounding and Bonding.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged units.
- B. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:
 - 1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.
 - 2. Check intensity and uniformity of illumination.]
 - 3. Check excessively noisy ballasts.
- C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities.

END OF SECTION 16521

SECTION 16821

AUDIO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Requirements for the audio system, processing, routing, inter-face, audio support, control, and all other peripheral and sup-port equipment.

1.2 DEFINITIONS

- A. Channels: Separate parallel signal paths, from sources to loud-speakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for loudspeaker alternative program signals.
- B. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different sources.
- C. VU: Volume unit.

1.3 DESCRIPTION OF WORK

- A. This specification defines the minimum requirements for the equipment and associated items for the audio-visual systems to be furnished and installed in the specified areas.
- B. The successful AV Contractor shall provide all equipment, materials, associated hardware, power supplies, labor, transportation and incidentals, and all work needed for the installation and testing of the audio-visual systems.
- C. The audio-visual systems equipment will be installed within the equipment racks indicated within these specifications, and within the Contracting Authority provided areas associated with the specified systems. It is the responsibility of the AV Contractor to verify space within racks, rooms, and cabinetry prior to installation as a portion of the Submittal Documents.
- D. It is the purpose of this specification to require the furnishing of the highest quality materials, equipment and workmanship. The work shall be in accordance with this specification and in conformity with the designs, layouts and descriptions shown on the drawings.
- E. Any and all structural, mounting, or rigging details within this package is strictly conceptual. It is the responsibility of the AV Contractor to employ the services of a structural engineer as necessary. Calculations shop drawings, and details of any structural modifications or additions shall be submitted to the Engineer for approval.
- F. Unless stated otherwise on the drawings, the work shall include everything necessary or incidental to complete the installation EXCEPT wire raceway (including conduit), raceway fittings, outlet boxes, pull boxes, terminal cabinets, 120 volt AC power circuits, lighting systems, and insulated ground cables. Such excluded equipment shall be furnished and installed by the Contracting Authority. The AV Contractor shall furnish all necessary information to the Contracting Authority to insure that a proper audio-visual conduit system will be in-stalled.

- G.** The AV Contractor shall cooperate with all other contractors engaged in this project and shall coordinate the installation of the audio-visual, systems so that all work will proceed in a manner which is in the best interests of the Contracting Authority.

1.4 SCHEDULING AND SEQUENCING OF WORK

- A.** The AV Contractor shall schedule and sequence the audio-visual system rough-in work to coordinate with the established general construction sequence as updated from time to time by the Contracting Authority.
- B.** Once the AV Contractor begins work at the project site, the company shall maintain a project manager for the duration of the work to supervise the work force and to provide coordination with other trades and/or the Contracting Authority.
- C.** The project manager shall attend any regularly scheduled construction progress meetings. These meetings will include, but not be limited to Contracting Authority and Engineer Meetings, walk through meetings with the Contracting Authority and Engineer, and weekly construction meetings.

1.5 SUBMITTALS

- A.** Product Data For the following:
 - 1. Preamplifiers/mixers.
 - 2. Power amplifiers.
 - 3. Equalizers.
 - 4. Microphones.
 - 5. Volume limiter/compressor
 - 6. Zone/room combiners.
 - 7. Equipment cabinet and rack.
 - 8. Loudspeakers.
 - 9. Audio processor.
 - 10. Control panels.
- B.** Shop Drawings:
 - 1. Rack Arrangements.
 - 2. Wiring diagrams: Power, signal, and control wiring. Include the following:
 - a. Identify terminals to facilitate installation, operation, and maintenance.
 - b. Single-line diagram showing interconnection of components.
 - c. Cabling diagram showing cabling routing.
- C.** Field quality-control test reports.
- D.** Operation and Maintenance Data: For public address and music equipment to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A.** Programmer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B.** Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

- C. Source Limitations: Obtain public address and music equipment through a single source authorized by manufacturer to distribute each product.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for in-tended use.
- E. The equipment manufacturers shall have a full-time service organization to provide prompt and efficient service, whose name, address and telephone number shall be provided to the Contracting Authority.
- F. The entire installation shall comply with all applicable electrical and safety codes. All applicable equipment shall be listed by Underwriter's Laboratories, Inc.
- G. The equipment design, installation, and testing shall meet or exceed the requirements of this specification, Local Government Building Codes, OSHA Publications, the National Electrical Code and the Federal Communications Commission (FCC) Rules and Regulations.
- H. Comply with NFPA 70.
- I. Comply with UL 50.

1.7 COORDINATION

- A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Atlas.
 - 2. Audio Technica.
 - 3. Belden.
 - 4. Biamp.
 - 5. Crown.
 - 6. Denon.
 - 7. Electro-Voice.
 - 8. Extron.
 - 9. Liberty.
 - 10. Middle Atlantic Products, Inc.
 - 11. Panasonic.
 - 12. QSC Audio, Inc.
 - 13. Shure.
 - 14. SoundTube.
 - 15. TOA Electronics, Inc.

2.2 ZONES

- A. See design documents for all zones and control layouts.

2.3 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Systems Functions: Include the following:
 1. Selectively connecting separate zones to different signal channels.
 2. Selectively amplifying sound among various inputs.
 3. Reproducing high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; and output free of nonuniform coverage of amplified sound.

2.4 EQUIPMENT AND MATERIALS

- A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

2.5 SYSTEM EQUIPMENT

- A. The sound system power shall be a backlit “One Touch” push button switch, located at the sound rack.
- B. Sound Contractor shall supply an umbilical from the wall boxes to the sound cabinet via flexible conduit or an approved flexible cover. Major system components are listed below. Verify all final locations prior to installation. Provide all switches, jacks, hardware, power supplies, and other equipment necessary for fully operational systems.

2.6 AMPLIFIERS

- A. Power Amplifier – 2 Channel Type 1:
 1. Comply with TIA/EIA SE-101A.
 2. Mounting: Rack-mounted.
 3. Output Power: 800 watts per channel.
 4. Shall support 100 volt distribution systems.
 5. Two-channel power amplifier shall be QSC ISA800Ti, Crown CTs, or approved equivalent.

2.7 AUDIO SOURCES

- A. CD Changer/Player:
 1. Shall be Denon DCM-390, Yamaha CD-C600, Marantz CC4003, or approved equivalent.

2.8 LOUD SPEAKERS

A. Loudspeaker Type 1:

1. Assemblies shall consist of 2-way, woofer and tweeter, within environment-resistant housings. Enclosure shall be constructed of paintable UV-resistant, talc impregnated, polypropylene, injection molded plastic.
2. Each unit shall include a stamped, powder-coated, aluminum grille and removable C-shaped mounting bracket. All hardware inserts shall be brass and threaded 1/4-inch-20. The 100 watt RMS system shall have a 5 1/4 inch woofer, constructed of reinforced polypropylene, and a 1 inch Ferrofluid cooled tweeter. The dividing network crossover frequency shall be 5kHz. The dividing network shall include protection circuits for the high-frequency component. Each unit shall include an internally mounted 30-watt 70.7V/100V line matching transformer for use in distributed sound applications wattage taps shall be screwdriver selectable via a sealed switch located near the input section. Wattage taps shall be 0.94, 1.9, 3.7, 7.5, 15, 30 @ 70.7V plus transformer bypass setting for direct coupled 8Ω operation. The loudspeaker system shall meet the following performance criteria: Power handling: 100 Watts RMS; Frequency response: 85Hz – 20kHz (±3dB); Pressure sensitivity, 90dB SPL at one watt, 100Hz measured at a distance of one meter on axis. Input connectors shall include a two-pole barrier strip capable of accepting up to two #16AWG cables. A tongue-in-groove cover with rubber wire exit grommet shall be provided to protect the input connectors from corrosion. The unit shall be 10 3/16 inches high, 6 7/8 inches wide, 5 7/8 inches deep. Weight shall be 7 lbs. Provide surface pole-mount.

2.9 AUDIO PROCESSOR

A. Digital Audio Processor and Router – Type 2:

1. 10 balanced mic/line inputs.
2. 6 balanced mic/line outputs.
3. Ethernet port for software configuration/control.
4. Serial port for third-party RS-232 remote control.
5. Remote control bus for dedicated control panels.
6. NexLink ports for multi-unit system designs.
7. Mix, route, combine, EQ, delay, control, etc.
8. Mixers: standard, automatic, matrix, combiners.
9. Equalizers: graphic, parametric, feedback.
10. Filters: HPF, LPF, high shelf, low shelf, all-pass.
11. Crossovers: 2-Way, 3-Way and 4-way.
12. Dynamics: leveler, comp/limiter, ducker, ANC.
13. Routers: 2x1 ~ 32x32.
14. Delays: 0 ~ 2000 ms.
15. Controls: levels, presets, logic, RS-232, etc.
16. Meters: signal present, peak, RMS.
17. Generators: tone, pink-noise, white-noise.
18. Diagnostics: transfer function.

B. Active Volume Control:

1. Adjustment of 8 selectable system volumes.
2. Volume control includes any combination of inputs and outputs.
3. Fully programmable remote control or selection functions for audio processor.

2.10 COMPONENTS

- A. Floor-Mount Equipment Cabinet TIA/EIA-310-D Compliant:
 - 1. Cabinet Housing: Fully welded construction with 1/8 inch thick structural steel internal bracing, with front vented doors, vented solid doors for racks on rear, end covers and standard TIA/EIA 19 inch rack.
 - 2. Provide two power strips per cabinet with 14 outlets per strip.
 - 3. Provide 3 foot ground bussbar in each rack.
 - 4. Finish shall be black powder coat.
 - 5. Racks shall be equipped with two pairs of 11 gauge steel rack rails with tapped 10 to 32 mounting holes in universal EIA spacing.
 - 6. Provide cable management for vertical and horizontal cabling.
 - 7. Provide blank panels for rack spaces not being used.

- B. Microphone Enclosure:
 - 1. Enclosure to have a NEMA-4 rating.
 - 2. Locking front panel.
 - 3. Have 2-gang Electrol plate mounting.
 - 4. Enclosure to be FSR OWB-CPI-WHT
 - 5. Paint enclosure to match existing power pedestal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. New Wiring: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces including plenum ceilings. Where possible for all audio cabling except microphone cables, microphone cables shall be installed in conduit. Conceal cables and raceways except in unfinished spaces. Cable shall be installed continuous with no splices or cuts.

- B. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings so de-signed and installed to avoid damage to cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

- D. Separation of Wires: Separate loudspeaker-microphone, line-level, loudspeaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for loudspeaker microphones and adjacent parallel power and telephone wiring.

- E. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

- F. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

- G. Wall-Mounting Outlets: Flush mounted.
- H. Conductor Sizing: Unless otherwise indicated, size loudspeaker circuit conductors from racks to loudspeaker panels not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG. All terminations of conductors shall be soldered connectors matching equipment adapters are not acceptable.
- I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- J. Loudspeaker-Line Matching Transformer Connections: Make initial connections using tap settings in middle of range.
- K. All terminations shall be installed per manufacturer's specifications and recommendations.

3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Schedule tests with at least seven days' advance notice of test performance.
 2. After installing public address and music equipment and after electrical circuitry has been energized, test for compliance with requirements.
 3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at final adjusted levels (FAL) gain settings as follows:
 - a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000 Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
 - b. Repeat test for each separately controlled zone of loudspeakers.
 - c. Minimum acceptance ratio is 50 dB.
 5. Distortion Test: Measure distortion at FAL gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
 6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in the same zone and between locations in adjacent zones shall not vary more than plus or minus 3 dB.

- B.** Retesting: Correct deficiencies, revising tap settings of loud-speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.
- C.** Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging loudspeaker-line matching transformers.

3.4 STARTUP SERVICE

- A.** Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- B.** Complete installation and startup checks according to manufacturer's latest revision of written or media instructions.

END OF SECTION 16821