

SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: This Section specifies several categories of provisions for electrical Work, including: 1) Certain adaptive expansions of requirements specified in Division 1; 2) General performance requirements within the electrical systems as a whole; and 3) General Work to be performed as electrical Work, because of its close association.
- B. Drawings: Refer to the Electrical Drawings for graphic representations, schedules, and notations showing electrical Work.
- C. Specifications: Refer to this Division 16 for the primary technical specifications of electrical Work.
- D. Work Included: This Work includes the furnishing of all labor, materials, equipment, fixtures, operators, and appurtenances required for complete installation of the major facilities and systems as follows:
 - 1. 120/208 Volt Power Distribution System.
 - 2. Lighting Systems.
 - 3. Grounding Systems.
 - 4. Telephone Distribution Raceway System.
 - 5. Electrical Connections to Equipment.
 - 6. HVAC Control Wiring.
 - 7. Emergency Lighting Systems.

8. Combination Fire Alarm System.
 9. Additional items shown on Drawings or specified herein.
- E. Work of Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division. The actual performance of the Work stays within the Section in which it occurs, subject to the requirements of this Section and to the extent applicable.
1. Finish painting is specified under Division 9. Prime and protective painting are included in the Work of this Division.
 2. Motors and motor starters that are an integral part of the equipment are furnished with the driven equipment under Division 15. However, all other motor starters, electrical wiring, and connections are included in the Work of this Division.
 3. Equipment control relays and electrical interlock devices are specified under Division 15, except as herein specified.
 4. Access doors in finished surfaces are specified under Division 8. Locations are shown on the Drawings, but all required access doors covering electrical Work shall be provided whether or not shown on the Drawings.
 5. Concrete housekeeping pads and conduit ductbank encasement are specified under Division 3. Dimensions, locations and responsibility of locations of pads, curbs, and ductbank are included in the Work of this Division.

1.3 QUALITY ASSURANCE AND STANDARDS:

- A. General: Refer to Division 1 for general administrative/proce-dural requirements related to compliance with codes and standards.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.
- C. Standards: This Work shall meet the standards set forth in the applicable portions of the following recognized codes and standards:
 1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90/75-R.

2. Association of Edison Illuminating Companies (AEIC).
3. Certified Ballast Manufacturers (CBM).
4. Factory Mutual (FM).
5. Institute of Electrical and Electronics Engineers (IEEE).
6. Illuminating Engineering Society (IES).
7. Insulated Power Cable Engineering Association (IPCEA).
8. National Electrical Code (NEC).
9. National Electrical Contractors' Association (NECA).
10. National Electrical Manufacturers' Association (NEMA).
11. National Fire Protection Association (NFPA).
12. Underwriters' Laboratories, Inc. (UL).
13. BOCA Basic Building Code, 1987 Edition.

1.4 CODES, PERMITS, AND FEES:

- A. General: Comply with the most recently revised versions of all applicable laws, rules, regulations, and ordinances of Federal, State, and Local Authorities. Modifications required by the above said Authorities shall be made without additional charge. Where alterations to and deviations from the Contract Documents are required by said Authority, report the requirements and secure approval before starting Work. Obtain all applicable permits and pay all fees charged by above Authorities.
- B. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern.
- C. Fire Rated Ceilings: Provide required protection for openings in ceilings, due to light fixtures or other required openings, with fire rated box or other approved method, whether or not shown on the Drawings.

1.5 SITE VISIT AND FAMILIARIZATION:

- A. General: Become familiar with the Drawings and Specifications and examine the premises and understand the conditions under which the Contract shall be performed.
- B. Site: Be informed of the utility companies from whom service is supplied; verify locations of utility services and determine the exact requirements and provisions for connection.

1.6 COORDINATION OF ELECTRICAL WORK:

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire Work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships that must be established within the electrical Work, and in its interface with other Work including utilities and mechanical Work, and that such establishment is the exclusive responsibility of the Contractor.
 - 1. Arrange electrical Work in a neat, well organized manner with conduit and similar services running parallel with primary lines of the building construction, and with a minimum of 7 feet-0 inches overhead clearance where possible.
 - 2. Locate operating and control equipment properly to provide easy access, and arrange entire electrical Work with adequate access for operation and maintenance, and for proper Code clearances.
 - 3. Advise other trades of openings required in their Work adequately in advance for the subsequent move-in of large units of electrical Work (equipment).
- B. Coordination Drawings: For locations where several elements of electrical (or combined mechanical and electrical) Work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings (shop drawings) showing the actual physical dimensions (at accurate scale) required for the installation. Prepare and submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
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1.7 DRAWINGS:

- A. General: The Drawings are schematic in nature and show approximate locations of feeders, circuits, panels, outlets, switches, fixtures, and other materials and devices of the electrical systems except where specific locations are noted and dimensioned on the Drawings. These items are shown approximately to scale and attempt to show how these items should be integrated with building construction. Locate all the various items by on-the-job measurements, conformance with Drawings, Code requirements, and in cooperation with other trades.
- B. Location: Prior to locating light fixtures, obtain approval as to the exact method of locating fixtures in the various areas. Fixture locations shall not be determined by scaling drawings. This Division shall relocate fixtures and incur cost of redoing work of other trades necessitated by failure to comply with this requirement. Where relocation of outlets, switches, boxes, and other devices is required within five feet of location shown on Drawings, and when Contractor is informed of necessary relocation before Work is begun on this portion of the job, no extra compensation will be allowed for relocation.

1.8 DISCREPANCIES:

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents, or questions as to the intent thereof.
- B. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of Work to be performed. Tender of a proposal conveys full agreement of the items and conditions specified, shown on the Drawings, and required by the nature of the project.

1.9 ADDENDA:

General: The Contractor shall be responsible for assuring he is fully informed of all addenda issued and has reviewed all Divisions for inclusion of Work under this Division. Any questions as to intent of Work to be done shall be clarified prior to bidding. Lack of understanding shall not justify a request for extra compensation to the Contract price.

1.10 PROJECT RECORD DOCUMENTS:

- A. Comply with pertinent provisions of Division 1.
- B. Construction Site Prints: Maintain a set of prints of the Contract Drawings at the job site which shall be used for recording the final size, location, interrelation, and other items or deviations of all Work under this Division. This set of Drawings shall be corrected daily as the Work progresses.
- C. "As-Built" Drawings: The Contractor shall transfer the information recorded on the job site set of prints to an "As-Built" document to be used for the production of Record Drawings. The Drawing shall indicate exact "As-Built" locations of all concealed piping, valves, and other equipment and devices. Critical dimensions shall clearly and accurately delineate equipment and device locations. Prior to final acceptance of the Work of this Division the Contractor shall submit copies of this document to the Contracting Officer for review and shall make changes, corrections, or additions as requested.
- D. Record Drawings: Include a copy of the Record Drawings in each copy of the operation and maintenance manual. Provide the Contracting Officer a copy for his files.
- E. Accuracy: The project record documents shall indicate exact locations of all concealed raceways installed and all pull and junction boxes that are not installed at locations shown.

1.11 SUBMITTALS:

- A. General: Submit shop drawings in accordance with the Conditions of the Contract and applicable requirements of Division 1. Shop drawings shall have final review prior to equipment ordering or fabrication. All reports or information requiring certification shall be certified by an authorized officer of the Manufacturer or testing agency.

1. Obtain, check, certify, and submit complete shop drawings and product data for all materials and equipment specified herein.
 2. Furnish certified shop drawings showing dimensions, loading details, anchor bolt locations, and all inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
 3. Equipment and material submittals shall show sufficient data including all performance curves, sound data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes. Verify that the equipment will fit the available space. List on all submittals any deviation from equipment or materials specified. Equipment submittals for manufacturers other than those called out on the Drawings shall include a comparison sheet listing capacities, motor sizes, etc., as noted in the schedules. Identify and note cut sheets as to which items are being submitted for review. If submittals are not so marked, they will be returned unchecked for resubmittal.
 4. Check all materials and equipment after their arrival on the job site and verify their compliance with the Contract Documents.
 5. A minimum period of two weeks, exclusive of transmittal time, will be required in the reviewer's office each time a shop drawing, product data, and/or samples are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling his Work.
 6. Submittals shall be grouped such that not more than two packages are submitted during the review process.
 7. The review of shop drawings shall not relieve the Contractor of the responsibility for dimensions or errors that may be contained therein, or for deviations from requirements in the Contract Documents. Noting some errors, but overlooking others, does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, the Contract Documents shall govern the Work.
 8. Certify that data and details set forth on each shop drawing complies with the Contract Documents for this project. Unless certified, shop drawings will not be reviewed, and will be returned unchecked to the Contractor.
- B. Shop Drawings and Product Data Brochures: Submittals shall contain all necessary information for review, including additional information when requested. Product Data Brochures shall contain only information relevant to the particular equipment or materials to be furnished. Unless all irrelevant information is deleted or unless

relevant information is clearly marked, including accessories, ratings, appurtenances, and dimensions as required, submittals will be returned marked "Rejected". Submittals for the Work shall include, but not be limited to:

1. Cable, Wire, and Connectors
2. Electrical Raceways and Fittings
3. Electrical Boxes and Fixtures: Include dimensioned drawings of special electrical boxes showing the accurately scaled boxes, their layout, and relation to associated equipment.
4. Panelboards and Enclosures: Include dimensioned drawings of panelboards and enclosures showing accurately scaled layout of enclosure and required unit sections, including but not necessarily limited to, circuit breakers, fusible switches, and accessories. Submit, if requested, transparencies of circuit breaker characteristics with unlatch times and fuse characteristics with melting/clearing times for use by the Contracting Officer in verifying coordination of these devices.
5. Electrical Gutters
6. Wiring Devices
7. Safety and Disconnect Switches: Include dimensioned drawings of electrical safety and disconnect switches that have a rating of 100 amperes or larger, showing the accurately scaled switches, their layout, and relation to associated equipment.
8. Switchboards: Include dimensioned drawings of switchboards showing accurately scaled basic units, including but not necessarily limited to, auxiliary compartments, metering compartments, unit components, and combination units. Submit, if requested, transparencies of fuse characteristics with melting/clearing times for use in verifying coordination of devices.
9. Fuses
10. Grounding Products: Include a complete grounding system diagram with materials and ground conductor sizes.
11. Motor Starters: Include dimensioned drawings of motor starters that have a NEMA size 3 or larger starter, accurately showing the scaled controllers and switches, their layout, and relation to associated equipment.

12. Miscellaneous Electrical Controls and Control Wiring: Include control-wiring diagrams for all miscellaneous electrical controls.
 13. Lighting Fixtures: Include certified test data showing return air performance of return air fixtures, both with heat extract slots only, and with heat extract slots and both side slots.
 14. Lamps
 15. Specialty Lighting Fixtures
 16. Fire Alarm System Components: Include shop drawings showing combination fire alarm system riser and wiring diagrams and dimensioned drawings of Fire Alarm Control Panel. Include certification that this Division has fully coordinated all fire alarm system signal and control connections to Work of other Divisions, including but not limited to, automatic temperature controls. Complete shop drawings shall be submitted to the local Fire Department for approval. Shop drawings submitted for review shall bear the approval stamp of all authorities having jurisdiction.
 17. Coordination Drawings: As required by Section 16010, Paragraph 1.06B.
 18. Housekeeping Pads: Include location and dimensions of housekeeping pads, including blockouts and anchor bolts.
 19. Firestops: Include all firestop materials for the project, indicating intended use and UL fire rating where applicable.
- C. Certifications and Test Reports: Submit 4 copies of all certifications and test reports adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems. Prior to conducting tests and certifications, submit proposed test procedures and recording forms for review by the Contracting Officer. Necessary tests and certifications are described under the appropriate Section of this Division 16 unless set forth herein below. Certifications and test reports to be submitted shall include, but not necessarily be limited to:
1. Thermographic Testing: Conduct a thermographic test using an infrared temperature-scanning unit. The test shall be performed by an independent testing laboratory (General Electric or Westinghouse Corp. Instrument Division). Connections indicating higher temperature levels than are acceptable shall be tightened or corrected as required to eliminate the condition. Conduct test, using test-reporting forms, upon beneficial occupancy. Correct unacceptable conditions. Conduct test on each major component of the Work including, switchboards, all feeders shown on the

- One Line Diagram, and feeder terminations at major equipment.
 2. Fire Alarm System.
 3. Emergency Lighting System.
 4. Wire and Cable Tests for Short Circuits and Insulation Resistance Values.
 5. Grounding System Tests.
 6. Voltage and Current Values for Distribution and Equipment Feeders.
 7. Switchboard Insulation Resistance Test.
- D. Warranties (Guarantees): Submit 5 copies of all warranties and guarantees for systems, equipment, devices, and materials (this includes 2 copies for maintenance manuals).
- E. Maintenance Manuals: Submit 2 copies, including wiring diagrams, maintenance and operating instructions, parts listings, and copies of all other submittals required by this Division 16. Organize each maintenance manual with Table of Contents, Index, and thumb-tab marked for each section of information. Bind in 2", 3-ring binders, vinyl covered, with pockets to contain folded sheets. Properly label contents on spine and face of binder.
- F. Samples: Submit 2 samples, upon request, of electrical devices and materials for review. Samples will be returned upon written request of the Contractor.
- G. Approval: Materials installed or Work performed without approval of material shall be done at the risk of the Contractor and the cost of removal of such material or Work which is judged unsatisfactory for any reason, shall be at the expense of the Contractor.

1.12 INSPECTION:

- A. Notice: Make written notice to the Contracting Officer adequately in advance of each of the following stages of construction:
1. In the underground condition prior to placing concrete floor slab, when all associated work is in place.
 2. When all rough-in is complete, but not covered.
 3. At completion of the Work of this Section.

- B. Corrections: When material and/or workmanship is found to not comply with the specified requirements, within three days after receipt of notice of such non-compliance, remove the non-complying items from the job site and replace them with items complying with the specified requirements, all at no additional cost.

1.13 RESPONSIBILITY

- A. General: The Contractor of this Division will be held responsible for any and all damage to any part of the building or to any part of the building or to the Work of other Division contractors, as may be caused through their operation.
- B. System Operation: The operation of the Electrical System during construction shall be the responsibility of the Contractor of this Division until the acceptance of the building by the Contracting Officer.
- C. System Operation Cost: The Contractor shall pay for all energy cost for operation of the plant until beneficial occupancy is obtained.

1.14 GUARANTEE

- A. The Contractor guarantees all Work against any defects due to faulty workmanship or material and that all raceways, ducts, and piping are free from foreign material, obstructions, holes, or breaks of any nature.
- B. Upon written notice from the Contracting Officer, the Contractor shall promptly remedy without cost any defects occurring within a period of one (1) year from the date of final acceptance.

1.15 ELECTRICAL PRODUCTS:

- A. General: Refer to Division 1 sections for general requirements on products, materials, equipment, and substitutions.
- B. Compatibility: Provide products which are compatible with other products of the electrical Work, with other Work requiring interface with the electrical Work, including electrical connections and control devices. For exposed electrical Work, coordinate colors and finishes with other Work. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes, and for adjustment, repair, or replacement.

- C. Substitutions: Materials and products of manufacturers other than those listed in this Specification require approval of the Contracting Officer in writing 10 days prior to bid date.

1.16 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. General: Ensure that all electrical equipment, devices, and materials arrive at the site in good condition, intact in factory package or crate. Any equipment found to be damaged shall be removed from the project site.
- B. Storage: Store all electrical equipment, devices, and materials in factory containers or package until ready for use. Storage facility shall be a clean, dry, indoor space that provides protection against weather. Avoid damage by condensation by providing temporary heating when required.
- C. Handling: Handle all electrical equipment, devices, and materials carefully to prevent breakage, denting, or scaring of the finish. Damaged materials shall be removed from the project site.

1.17 SCOPE SPECIFICATIONS:

- A. These Specifications are issued in conjunction with the Drawings which indicate the general scope of the Project in terms of the architectural design concept, the dimensions of the building, the type of structural, mechanical, electrical and utility systems, and outline notes of major architectural elements of construction. As "Scope" documents, the Drawings and Specifications do not necessarily indicate or describe all work required for the full performance and completion of the Work.
- B. Contracts may be let on the basis of such documents, only if approved by the Contracting Officer, with the understanding that the Contractor is to furnish all items required for proper completion of the Work without adjustment to Contract Price. It is intended that the Work be of sound and quality construction and the Contractor shall be solely responsible for the inclusion of adequate amounts to cover installation of all items indicated, described, or reasonably implied.

PARTS 2 AND 3 - PRODUCTS AND EXECUTION

2.1 TEMPORARY FACILITIES

- A. General: Refer to Division 1 for general requirements on temporary facilities.

- B. Temporary Power: Provide temporary 120/208V power, where directed by the Contractor, to be used during construction. Remove from the job site upon completion of the work.

2.2 MATERIALS AND WORKMANSHIP:

- A. General: All materials and equipment shall be new and of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment. Those of the same type shall be by the same Manufacturer.
- B. Workmanship: Work shall be executed and all materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when complete.
- C. Manufacturer's Recommendations: With exceptions as specified and/or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per Manufacturer's current printed recommendations. Keep copies of such printed recommendations at job site, and make them available as required.

2.3 EQUIPMENT SCHEDULED:

- A. General: The design is based on the equipment scheduled; therefore, equipment furnished by other manufacturers named in the Specifications shall have prior approval of the Contracting Officer. Materials and equipment shall be new and in good condition. The commercially standard items of equipment, and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the Work. Since manufacturing methods vary, reasonable minor variations are expected; however, performance and material requirements are the minimum standards acceptable. Where modifications are required to accommodate selections other than those scheduled, the Contractor shall bear all costs.
- B. Equal Products: Equal products may be considered if submitted in writing in accordance with Division 1 requirements. The Contractor shall also be responsible for assuring the items meet the requirements outlined in paragraph 2.04, "Space Requirements."

2.4 SPACE REQUIREMENTS:

- A. General: Determine in advance of purchase that the equipment and materials

proposed for installation will fit into the confines indicated, leaving adequate clearances for adjustment, repair, or replacement.

- B. Clearance: Allow adequate space for clearance in accordance with the Code requirements, and the requirements of the local inspection department.
- C. Responsibility: Since space requirements and equipment arrangement vary for each Manufacturer, the responsibility for initial access and proper fit rests with the Contractor.
- D. Review: Final arrangements of equipment to be installed shall be subject to the Contracting Officer's review.

2.5 DELIVERY, STORAGE, AND HANDLING OF MATERIALS:

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage. Comply with pertinent provisions of Division 1.
- B. Scope: Work under this Division shall include:
 - 1. Shipping from point of manufacture to job site.
 - 2. Storage on-site as required.
 - 3. Hoisting and scaffolding of materials and equipment included in this Division.
 - 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

2.6 CUTTING AND PATCHING:

- A. General: Comply with the requirements of Division 1 for cutting and patching of other work to accommodate the installation of work under this Division. Place all equipment in time to avoid cutting new construction.
- B. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no additional expense. Undertake no cutting or patching without first securing approval. All patching shall create a surface that is structurally and aesthetically equal to the surface surrounding the area patched.

2.7 EXCAVATION AND BACKFILLING

- A. General: Perform trenching and backfilling in strict accordance with the provisions of Division 2. Coordinate the Division's Work with other Work in the same area, including dewatering, flood protection provisions, temporary facilities, other underground services (existing and new), landscape development, paving, slabs on grade, sidewalks, etc.
- B. Replacement of Other Work: Where it is necessary to remove and replace landscape work, pavement, flooring, and similar exposed finish work, engage the original Installer to install the replacement work. If the work existed prior to the work of this Contract, engage only experienced and expert firms and tradespersons to replace the work (includes existing utilities and services). Contractor shall include for all such Work in his proposal.

2.8 NOISE AND VIBRATION:

General: Warrant the electrical systems and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment that results in noise within occupied spaces above the recommended values (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

2.9 ELECTRICAL SYSTEM IDENTIFICATION:

- A. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces, to distinguish each run as either a power or signal/communication conduit. Except as otherwise indicated, use orange banding with black lettering. Provide self-adhesive or snap-on type plastic markers. Indicate voltage ratings of conductors exceeding 250 volts. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors or enters non-accessible construction, and at spacing of not more than 50 feet along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than 1".
- B. Underground Cable Identification: Bury a continuous, pre-printed, bright-colored plastic ribbon cable marker with each underground cable (or group of cables), regardless of whether conductors are in conduit or direct buried. Locate each directly over cables, 6" to 8" below finished grade.
- C. Cable/Conductor Identification: Coordinate a uniform and consistent scheme of color identification throughout the building system. Identification shall be by the

permanent color of the selected covering. On large conductors, secure identification by means of painted color banding or colored plastic tape. Color scheme shall be as follows:

120/208 Volt

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

D. Identification of Equipment:

1. All major equipment shall have a Manufacturer's label identifying the Manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
2. A black-white-black laminated plastic engraved identifying nameplate shall be secured by screws to each switchboard, distribution panel, motor control center, panelboard, safety switch, disconnect switch, terminal cabinet, and individual motor starter. Identifying nameplates shall have 1/2" high-engraved letters. Each switchboard, distribution panel, and motor control center device shall have a nameplate showing the load served in 1/4" high-engraved letters.
3. Cardholders and directory cards shall be furnished for circuit identification in panelboards. Cardholder shall be located on inside of panel door and shall be in metal frame with clear plastic front. Circuit lists shall be typewritten. Circuit descriptions shall include location and name of each item of equipment served.
4. An embossed plastic tape or other approved method shall be attached to each lighting and power J-box clearly indicating the panel and branch circuit numbers available at that J-box.

E. Prohibited Markings: Markings which are intended to identify the Manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also prohibited are materials or devices that bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters' Laboratories), and approval labels are exceptions to this requirement.

F. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of

sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

- G. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either pre-printed or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING."

2.10 PAINTING

- A. General: All painting of electrical equipment, devices, ductwork and piping shall be provided for under Division 9 finishes. This Contractor shall prepare material surfaces for Finish Work. Division 9 Contractor shall refer to architectural finish schedule for color and type of finish. On insulation use only paint which is recommended by the insulation Manufacturer.
- B. Items to be painted: Painting shall be required for the following items: All conduit and equipment exposed in finished areas and as noted in electrical rooms.

2.11 CLEANING, ADJUSTING AND PLACING IN SERVICE

- A. General: Contractors working under this Division shall clean up dirt and refuse resulting from his Work during construction so it does not interfere with other trades and shall make a final cleanup prior to final inspection. The Contractor shall maintain supplies, tools, and equipment left on the job site in a neat and orderly manner and shall assist in keeping the premises clean at all times.
- B. Installed material and equipment: Immediately prior to final inspection, the Contractor shall clean all material and equipment installed under this contract. Dirt, dust, plaster, stains and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original condition.
- C. Adjustment: Energize all systems, equipment, and fixtures. Mechanism of all equipment shall be checked, adjusted, and prepared for proper operation. Follow procedures outlined by the Manufacturer and as noted in the specifications and on the Drawings.
- D. Start-up Services: Where specified for any individual item of equipment (i.e. generators), provide a factory authorized representative for testing, start-up of equipment, and instruction of operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the Manufacturer.

- E. Lubrication: Provide means for lubricating all bearings and other machine parts. Extend a lubrication tube with suitable fitting to an accessible location and suitably identify it where lubrication fittings are concealed or inaccessible. Lubricate all parts requiring lubrication, and keep them adequately lubricated until final acceptance.

2.12 LOOSE EQUIPMENT AND SERVICE TOOLS

General: All keys and any special tools furnished with the equipment or required for maintenance of systems, equipment and apparatus installed under this Division shall be kept in a safe place during construction and presented to the Contracting Officer or his authorized representative at the completion of the project prior to requesting final acceptance of the installation.

2.13 OPERATING AND MAINTENANCE MANUAL AND INSTRUCTION

- A. General: Refer to Section 16010, 1.13 "Submittals", paragraph 'E' and Division 1 of these Specifications for general requirements.
- B. Manual: Prepare manuals in bound form with index and thumb tab markers for each Section, and identified with lettering imprinted on the face of binder. Include within each manual:
 1. Copy of the approved record documents for this portion of the Work.
 2. Copies of all warranties, guarantees, and test reports. Test records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests.
 3. Description of equipment control, including schedule of required maintenance. Wiring diagrams shall be complete with instructions outlining each sequential step in the start-up and shutdown of the systems. Include precautions and instructions for servicing each item of the system.
 4. Listing of all equipment. The list shall include identification, location and duties. This shall also include all system components.
 5. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams.

6. Fully detailed parts lists, including all numbered parts, of each item of equipment and apparatus provided under this Division.
 7. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.
- C. Approval: Submit 1 copy of Manual for content and format approval prior to final preparation.
- D. Record: Submit 4 copies of Manual for record as a Contract deliverable item. Manuals shall be complete, approved, and delivered to the Contracting Officer's authorized representative prior to requesting final acceptance of the installation.
- E. Instruction: The Contractor's service personnel shall instruct the Contracting Officer's Representative in the proper operation of all systems.

2.14 FINAL REVIEW

- A. General: Upon completion of the Work, perform a final test of the entire system.
1. The system shall be operating properly with all phases balanced.
 2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications and/or the Drawings shall be accomplished without delay in order to secure final acceptance of the Work.
 3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations that the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the number of days allotted for completion and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
 4. Certificates, including certificates of occupancy from local authorities, and documents required herein, shall be completely in order and presented to the Contracting Officer at least 1 week prior to the review.
- B. Qualified person: Individuals knowledgeable of the systems and persons approved by the Contracting Officer, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

2.15 ELECTRICAL WORK CLOSEOUT:

- A. General: Refer to Division 1 for general closeout requirements.
- B. Coordination with Mechanical Work: Coordinate closeout operations with closeout of mechanical systems, elevators, and other power-consuming equipment.
- C. Support Services: Test run electrical equipment in coordination with test runs of mechanical systems. Clean and lubricate operational equipment. Instruct operating personnel thoroughly in the operation, sequencing, maintenance, and safety/emergency provisions of the electrical systems. Turn over the operation to personnel at the time of substantial completion. Until the time of final acceptance of the total Work of the Contract, respond promptly with consultation and services to assist operating personnel with operation of electrical systems.

END OF SECTION

SECTION 16020

ELECTRICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. General: Provide all labor, materials, tools, machinery, equipment, appliances, and services necessary to complete the specified electrical Work of this Division. Coordinate Work with other trades to prevent conflicts without impeding job progress.
- B. Utility Charges: The Contractor shall pay all fees, meter charges, and special fees assessed by the local utilities or local authorities.
- C. Work Included: The Work includes, but is not limited to, the following systems, equipment, and services:
 - 1. Power distribution system consisting of the following:
 - a. Switchboards
 - b. Distribution Panels
 - c. Branch circuit panelboards
 - d. Motor starters
 - e. Wire & cable
 - f. Conduits, raceways and fittings
 - g. Gutters and wireways
 - h. Safety and disconnect switches
 - i. Fuses and circuit breakers
 - j. Cable Trays
 - 2. Electrical connections to equipment.
 - 3. Lighting fixtures, lamps and ballasts.
 - 4. Wiring devices.

5. Telephone system conduit and wiring.
6. Electrical grounding system.
7. Control and temperature control wiring.
8. Fire alarm system.

PART 2 - PRODUCTS:

2.1 GENERAL:

Refer to specific Sections of the Specifications for equipment.

PART 3 - EXECUTION:

3.1 GENERAL:

Installation shall be in accordance with the Specification Section pertaining to the individual equipment.

END OF SECTION

SECTION 16110

ELECTRICAL RACEWAYS AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical raceway and fitting Work as shown, scheduled, indicated, and specified.
- B. Types: The types of electrical raceways and fittings required for the project include the following:
 - 1. Rigid steel and intermediate metal conduit (IMC)
 - 2. PVC-coated rigid steel conduit
 - 3. Electrical metallic tubing (EMT)
 - 4. Flexible metal conduit
 - 5. Liquid-tight flexible metal conduit
 - 6. Rigid non-metallic conduit.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. Rigid Steel and Intermediate Metal Conduit:
 - a. Allied Tube & Conduit Corp.
 - b. Jones & Laughlin Steel Corp.
 - c. Republic Steel Corp.
 - d. Triangle PWC, Inc.

- e. Youngstown Sheet & Tube
2. PVC Coated Rigid Steel:
- a. Allied Tube & Conduit Corp.
 - b. Flexi-Guard, Inc.
 - c. OCAL
 - d. Republic Steel Corp.
 - e. Triangle PWC, Inc.
 - f. Youngstown Sheet & Tube
3. EMT:
- a. Allied Tube & Conduit Corp.
 - b. Anaconda Co.
 - c. ETP-Uni-Couple
 - d. Jones & Laughlin Steel Corp.
 - e. Republic Steel Corp.
 - f. Triangle PWC, Inc.
 - g. Youngstown Sheet & Tube
4. Flexible Metal and Liquid-Tight Flexible Metal:
- a. Anaconda Metal Hose
 - b. Electri-Flex Co.
 - c. Flexi-Guard, Inc.
 - d. Triangle PWC, Inc.
5. Rigid Non-Metallic:
- a. Amoco Chemicals Corp.
 - b. Anaconda Metal Hose
 - c. Carlon
 - d. Triangle PWC, Inc.
6. Raceway Fittings:
- a. Amoco Chemicals Corp.
 - b. Appleton Electric Co.
 - c. Carlon
 - d. Crouse Hinds
 - e. Efcor Division
 - f. ETP-Uni-Couple
 - g. O. Z. Gedney Co.
 - h. Republic Steel Corp.

i. Steel City.

B. UL Label: All electrical raceways and fittings shall be UL labeled.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.
- B. Rigid Steel and Intermediate Metal Conduit: Use rigid steel or intermediate metal conduit to run all electrical raceway systems where cast in concrete walls or floor slabs which have waterproof membranes, and where cast in masonry walls. Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable. Conduit smaller than 1/2-inch in diameter will not be permitted. EMT conduit may be used in lieu of rigid steel or intermediate metal conduit for feeder raceways, if the location is acceptable for use of EMT as described herein below.
- C. EMT: Use EMT for branch circuit electrical raceway systems where concealed in furred ceilings or in walls, exposed inside where not exposed to physical damage. Use compression type couplings and fittings made-up tight for conduit size 2 inches and smaller. Use setscrew type couplings and fittings for conduit greater than 2". Use watertight couplings and fittings where required. Where cast in concrete and floor slabs, use concrete tight couplings and fittings and terminate conduit in a box cast in concrete, or with rigid steel conduit turn-outs from concrete. Conduit smaller than 1/2-inch diameter will not be permitted.
- D. Flexible Metal: Use flexible metal conduit and fittings for lighting fixture connections and for other electrical equipment connections where subject to movement and vibration. Use flexible metal conduit from outlet boxes to lighting fixtures in such lengths as required, 6 feet maximum. Conduit smaller than 1/2-inch in diameter will not be permitted except that 3/8-inch flexible metallic conduit may be used for lighting fixture "pigtails".
- E. Liquid-tight Flexible Metal: Use liquid-tight flexible metal conduit and fittings for all motor connections and for other electrical equipment connections where subject to movement and vibration, and when subject to one or more of the following conditions: exterior location; moist or humid atmosphere where condensate can be expected to accumulate; corrosive atmosphere; subject to water spray; subject to

dripping oil, grease, or water. Conduit smaller than 1/2-inch in diameter will not be permitted.

- F. Rigid Non-metallic: Use rigid PVC Schedule 40 conduit and solvent type fittings for electrical raceway systems where shown, with or without concrete encasement. Conduit shall be Type II designated for underground installation with or without concrete encasement. Conduit system shall be UL listed in accordance with Article 347 of the NEC. Conduit smaller than 1/2-inch in diameter will not be permitted. Rigid PVC Schedule 40 conduit may be used in poured concrete walls and floor slabs, maximum size of 3/4".

2.2 METAL CONDUIT, TUBING, AND FITTINGS:

- A. General: Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not indicated, provide proper selection determined by Section 16110 to fulfill the wiring requirements and complying with the NEC for electrical raceways.

B. Metal Conduit:

1. Rigid Steel and Intermediate Metal Conduit: ANSI C80.1, hot-dip galvanized.
2. PVC Externally-Coated Rigid Steel Conduit: ANSI C80.1 and NEMA Std. RN1, hot-dip galvanized.
3. Rigid Steel or Intermediate Metal Conduit Fittings: ANSI C80.4.
4. EMT: ANSI C80.3, galvanized.
5. EMT Fittings: ANSI C80.4, galvanized.

C. Flexible Metal Conduit:

1. Type: Zinc-coated steel.
2. Flexible Metal Conduit Fittings: Zinc-coated steel.
3. Liquid-tight Flexible Metal Conduit: Liquid-tight flexible metal conduit comprised of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquid-tight jacket of flexible PVC.
4. Liquid-tight Flexible Metal Conduit Fittings: Liquid-tight, zinc-coated

steel.

- D. Non-metallic Conduit Fittings:
 - 1. Rigid PVC Schedule 40 Conduit: NEMA Std. TC-2.
 - 2. PVC Conduit Fittings: NEMA Std. TC-3.
- E. Conduit Tubing Accessories: Provide conduit and tubing accessories including straps, hangers, and expansion joints as recommended by the conduit and tubing Manufacturer and as specified in Section 16110.

PART 3 - EXECUTION

3.1 INSTALLATION:

General: Install electrical raceways and fittings as shown, in accordance with the Manufacturer's written instructions, applicable requirements of NEC, and in accordance with recognized industry practices to ensure that products serve intended function. Complete electrical raceway installation before starting the installation of cables.

3.2 INTERIOR CONDUIT SYSTEM:

- A. General: Ground all metallic conduit in accordance with the requirements of the latest edition of the NEC.
- B. Install all conduits as a complete system without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in such a manner as to ensure a tight joint. Fasten the entire conduit system securely into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting. Install approved expansion fittings in all conduit runs exceeding 150 feet or when crossing building expansion joints.
- C. Ream all ends of conduit properly to remove rough edges. Whenever a rigid steel or IMC conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by the use of a locknut inside and outside and an approved insulating grounding bushing shall be installed. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector. Lay out and install all conduit systems as to avoid all other services or systems, the proximity of which may prove injurious to the conduit

or the wires or conductors which the conduit confines.

- D. Conceal conduit systems in finished areas. Conduit may be exposed in mechanical rooms and where otherwise shown or indicated. On exposed systems, run the conduit parallel or perpendicular to the structural features of the building and rigidly support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners insofar as practicable.
- E. All conduits shall be run without traps. Where traps or dips are unavoidable, a junction or pull box shall be placed at each low point. Ensure that access to boxes is maintained by using access panels in ceilings, walls, etc.
- F. Support exposed raceway on galvanized channel using compatible galvanized fittings (bolts, beam clamps, and similar items) and galvanized threaded rod pendants to secure raceway to channel and channel to structure. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt/nut and threaded rod. All raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on all conduit passing through walls and ceilings in finished areas.
- G. Support conduit concealed in ceiling cavities with No. 13 AWG galvanized iron wire pendants, spaced not to exceed 9 feet apart, secured to conduit with clips and properly secured to structure. Branch circuit conduit 3/4-inch trade size and smaller may be suspended using "caddy clips" attached to the ceiling support system in a manner acceptable to the ceiling installer. Support conduit sized 1-1/4 inches and larger as described in Paragraph F. Perforated strap shall not be used for conduit supports.
- H. Make all joints and connections to ensure mechanical strength and electrical continuity. PVC conduit shall be joined, or have fittings attached, by using a fusing (solvent) compound recommended by, and applied as instructed by, the conduit Manufacturer.
- I. Run conduit to avoid proximity to heat producing equipment, piping, and flues, keeping a minimum of 8 inches clear. Whenever possible, install horizontal raceway runs above water piping. Unless shown otherwise, do not install conduit horizontally in concrete slabs without written approval. All roof penetrations shall be made in adequate time to allow the Roofer to make proper flashings. Conduit shall not be run in or through ductwork.
- J. Carefully review architectural, structural, mechanical, plumbing, and electrical drawings and place boxes and conduit to avoid conflicts with structural members or other general construction.

- K. Furnish sleeves for timely placing in construction for all conduit passing through concrete walls, partitions, beams, floors, and roofs while same are under construction. A conduit sleeve shall be one size larger than the size of conduit that it serves except where larger sizes are required for manufactured water, fire, or smoke stop fittings.
- L. Sleeves set in concrete floor construction shall be minimum 18 gage galvanized steel. Sleeves shall extend 2 inches above the finished floor. All conduit passing through concrete or masonry walls shall have Schedule 40 galvanized steel sleeves. Sleeves shall be set flush with finished wall. If holes and sleeves are not properly installed and cutting and patching becomes necessary, it shall be done by the responsible parties at no expense. Undertake no cutting or patching without first securing approval. Install manufactured UL listed water, fire, and smoke stop fittings, or calk around conduit or cables in sleeves with sufficient UL listed fire safing insulation or foam to maintain wall or floor slab fire rating. Where penetrations must be waterproofed, install manufactured water stop fittings, or properly calk with oakum and run full of asphalt mastic.
- M. Sleeves penetrating walls below grade shall be Schedule 40 black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be 2-inches wider all around than the sleeve that it encircles. The entire assembly shall be hot-dipped galvanized after fabrication.
- N. All conduit passing through the housing on connected equipment, shall pass through a cleanly cut hole protected with an approved grommet.
- O. Coordinate locations or raceways in fire rated partitions so as not to affect the fire rating of the partition. Notify the Contracting Officer in writing where additional construction is required to maintain the partition fire rating.

3.3 TELEPHONE SYSTEM RACEWAYS:

General: Conduit shall be installed in accordance with the previous specified requirements for conduit and tubing and shall not contain more than two 90-degree bends or the equivalent thereof. Pull or junction boxes shall be installed to comply with these requirements. Empty telephone raceways shall include a pull wire or cord, as described in paragraph 3.03 herein below.

3.4 EMPTY CONDUIT RACEWAY SYSTEM:

General: Empty conduit in which wire is to be installed by others shall have pull wires

installed. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200-pound tensile strength. Not less than 48 inches of slack shall be left at each end of the pull wire.

END OF SECTION

SECTION 16120

CABLE, WIRE, AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical cable, wire, and connector Work as shown, scheduled, indicated, and as specified.
- B. Types: The types of cable, wire, and connectors required for the project include the following:
 - 1. 600 volt building wire and cable
 - 2. 600 volt building wire and cable connectors.
- C. Application: The applications for cable, wire, and connectors required on the project are as follows:
 - 1. Power distribution circuitry
 - 2. Lighting branch circuitry
 - 3. Appliance, receptacle, and equipment branch circuitry
 - 4. Motor branch circuitry
 - 5. Control wiring
 - 6. Fire alarm wiring

1.3 QUALITY ASSURANCE:

- A. MANUFACTURERS: Provide products produced by one of the following:

1. Cable and Wire:
 - a. Anaconda Wire and Cable Co.
 - b. Cerro Wire and Cable Co.
 - c. Cyprus Wire and Cable Co.
 - d. Electrical Cable Div., USS Corp.
 - e. Essex International, Inc.
 - f. General Cable Corp.
 - g. Okonite Co.
 - h. Phelps Dodge Cable and Wire Co.
 - i. Southwire Company
 - j. Triangle PWC, Inc.
 - k. Wire and Cable Dept., General Electric Co.

2. Connectors:
 - a. AMP, Inc.
 - b. Burndy Corp.
 - c. General Electric Co.
 - d. Ideal Industries, Inc.
 - e. Mac Products, Inc.
 - f. Minnesota Mining and Mfg. Co.
 - g. O. Z. Gedney Co.
 - h. Thomas & Betts Co.

B. UL Label: All cable, wire, and connectors shall be UL labeled.

PART 2 - PRODUCTS

2.1 600 VOLT BUILDING CABLE, WIRE, AND CONNECTORS:

- A. General: Except as otherwise indicated, provide cable, wire, and connectors of Manufacturer's standard materials, as indicated by his published product information, designed and constructed by the Manufacturer, and as required for the installation.
- B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each use.
- C. Conductors: Provide soft or annealed copper wires meeting, before stranding, the requirements of ASTM B-3, "Standard Specification for Soft or Annealed Copper

Wire for Electrical Purposes", latest edition.

1. Conductors for power wiring sized No. 12 AWG through No. 10 AWG shall be solid.
 2. Conductors sized No. 8 AWG and larger shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B-8, "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft".
 3. Conductors for control wiring sized No. 18 AWG through No. 10 AWG shall be stranded.
- D. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires".
1. Insulation for conductors sized No. 18 AWG through No. 10 AWG shall be UL Type THHN/THWN.
 2. Insulation for conductors sized No. 8 AWG and larger shall be UL Type THHN/THWN.
 3. All wiring inside lighting fixtures shall be temperature rated per the NEC.
 4. Branch circuit wiring within 3-inches of fluorescent ballasts shall be temperature rated for 90°C.
- E. Connectors for Building Wire and Cable: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for each use.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install electrical cable, wire, and connectors as shown, in accordance with the Manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Coordination: Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. 600 Volt Building Wire and Cable:

1. Unless otherwise shown on the Drawings or Panel Schedules, use No. 12 type THHN conductors for all branch circuits, protected by 20 amp circuit breakers. Where so indicated on the Drawings or Panel Schedules, use larger wires to limit voltage drops.
2. The number of wires in a lighting or general power branch circuit conduit is indicated on the Drawings by cross lines (hashmarks) on the conduit runs.
 - a. Where no cross lines are shown, continue with number of conductors as previously indicated until number of conductors is shown differently.
 - b. Where wire size is not indicated, install No. 12 conductors, unless larger conductors are required.
 - c. Where conduit size is not indicated, install 1/2-inch conduit, unless larger conduit is required.
 - d. Provide code-size conduit for number and size wires shown or required, unless a larger size conduit is shown on the Drawings.
3. Pull all conductors together when more than one is being installed in a raceway. Whenever possible, pull all conductors into their respective conduits by hand. Use pulling compound or lubricant when necessary; compound shall not deteriorate conductor or insulation.
4. Before any wire or cable is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire to be pulled into a clean, dry conduit.
5. Run all feeders their entire length in continuous section without joints or splices.
6. No wire smaller than No. 12 AWG will be permitted for any lighting or power circuit except that No. 14 AWG Type THHN wire may be used for lighting fixture "pig-tails". No wire smaller than No. 18 AWG shall be utilized for any control circuit, unless shown otherwise.
7. For branch circuits operating at 150 Volts or less, utilize No. 10 AWG wire when the first outlet is in excess of 100 feet from the panelboard; for branch circuits operating at 150 to 300 volts, utilize No. 10 AWG wire when the first outlet is in excess of 150 feet from the panelboard. Branch circuit voltage drop shall not exceed 3 percent of rated branch voltage.
8. No tap or splice shall be made in any conductor except in outlet boxes, pull

boxes, junction boxes, splice boxes, or other accessible locations. Make all taps and splices by the use of an approved type compression connector. Insulate all taps and splices equal to that of the adjoining wire. Make splices or taps only on such conductors as are a component part of a single circuit, properly protected by approved methods.

9. Support all conductors in vertical raceways, as specified in Section 300-19 of the NEC.
 10. Do not permit conductors entering or leaving a junction or pull box to deflect so as to cause pressure on the conductor insulation.
 11. Make joints in branch circuits only where such circuits divide. These shall consist of one through circuit to which shall be spliced the branch from the circuit.
 12. Make connections in conductors up to a maximum of one No. 6 AWG wire with two No. 8 AWG wires using twist-on pressure connectors of required size.
 13. Make connections in conductors or combinations of conductors larger than described herein above using cable fittings of the type and size required for the specific duty.
 14. After a splice is securely "made-up", insulate entire assembly with UL-approved insulating tape to a value equivalent to the adjacent insulation.
 15. Make all splices and connections in control circuit conductors using UL-approved solderless crimp connectors.
 16. Make all grounding connections using ground clamps, connectors, or exothermic welds of a type suitable and UL-approved for duty involved.
- D. Signal System Wiring (low voltage) shall be installed where indicated in accordance with Manufacturer's recommendations. All runs shall be run in conduit.

3.2 TESTING:

- A. Pre-Energization Check: Prior to energization, check cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected.
- B. Feeder Insulation Resistance Test: Each main 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 VDC. Resistance shall be measured from conductor to conductor and from conductor to ground. Insulation resistance shall not be less than the following:

<u>Wire Size (AWG)</u>	<u>Insulation Resistance (Ohms)</u>
No. 12	1,000 K
No. 10 through No. 8	250 K
No. 6 through No. 2	100 K
No. 1 through No. 4/0	50 K
Larger than No. 4/0	25 K

2. Conductors that do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.
- C. Voltage and Current Values: The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.
- D. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit 4 copies of certified test results to Contracting Officer for review. Test reports shall include conductor tested, date and time of test, relative humidity, temperature, and weather conditions.

END OF SECTION

SECTION 16130

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical box and fitting Work as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical boxes and fittings required for the project include the following:
 - 1. Outlet boxes
 - 2. Junction boxes
 - 3. Pull boxes
 - 4. Floor boxes
 - 5. Fire rated poke-thru boxes
 - 6. Conduit bodies
 - 7. Bushings
 - 8. Locknuts.

1.3 QUALITY ASSURANCE:

- A. MANUFACTURERS: Provide products produced by one of the following:
 - 1. Interior Outlet Boxes:

- a. Appleton Electric Co.
 - b. Arrow Conduit and Fittings Corp.
 - c. National Electric Products Co.
 - d. O. Z. Gedney Co.
 - e. Steel City, Midland-Ross Corp.
2. Weatherproof Outlet Boxes:
- a. Appleton Electric Co.
 - b. Crouse-Hinds Co.
 - c. Harvey Hubbell, Inc.
 - d. Pyle-National Co.
3. Junction and Pull Boxes:
- a. Appleton Electric Co.
 - b. Arrow-Hart, Inc.
 - c. General Electric Co.
 - d. Hoffman Engineering Co.
 - e. Keystone Columbia, Inc.
 - f. O. Z. Gedney Co.
 - g. Square D Co.
4. Floor Boxes:
- a. Harvey Hubbell, Inc.
 - b. Steel City, Midland-Ross Corp.
 - c. Walker Parkersburg Division of Textron, Inc.
5. Fire Rated Poke-Thru Boxes:
- a. Dual-Lite Wiring Products Division
 - b. Harvey Hubbell, Inc.
 - c. Nelson Electric
 - d. Raceway Products
 - e. Square D
 - f. Walker Parkersburg Division of Textron, Inc.
6. Conduit Bodies:
- a. Appleton Electric Co.
 - b. Crouse-Hinds Co.
 - c. Killark Electric Mfg. Co.
 - d. Pyle-National Co.

7. Bushings, Knockout Closures, and Locknuts:

- a. Allen-Stevens Conduit Fittings Corp.
- b. Allied Metal Stamping, Inc.
- c. Appleton Electric Co.
- d. Carr Co.
- e. Raco, Inc.
- f. Steel City, Midland-Ross Corp.
- g. Thomas and Betts Co., Inc.

B. UL Label: All electrical boxes and fittings shall be UL labeled.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "Gang" boxes where devices are shown to be grouped.

1. Type for Various Locations:

- a. Ceiling Plenums: 4 inches square, 2-1/8 inches deep.
- b. Plaster Walls: 4 inches square, 2-1/8 inches deep, with raised plaster cover; set with face approximately 1/8 inches from finished surface. Furnish shallow boxes where necessary.
- c. Dry-wall Construction Walls: Standard galvanized switch box, 2-1/8 inches deep. Furnish shallow boxes where necessary.
- d. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.
- e. Surface: Type FS or FD box with surface cover.
- f. Poured concrete walls and ceilings: Concrete tight galvanized boxes, 4" square or 2" x 4", 2-1/8" deep, as required by device installed.

and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion-resistant screws.

- F. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts, and insulated conduit bushings of the type and size to suit each respective use and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS:

- A. Install electrical boxes and fittings as shown, in compliance with NEC requirements, or in accordance with the Manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
- B. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas, where exposed junction or pull boxes may be located.
- C. Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the Contracting Officer of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the Work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.
- D. Unless otherwise noted or directed to the contrary at the time of installation, outlet boxes shall be placed at the following heights (center of box to finished floor level):
 - 1. Wall switches: 54"
 - 2. Wall pay-telephone outlets: 48"
 - 3. Receptacles: 12"
 - 4. Telephone outlets (standard): 12"

5. Thermostats: 54"
- E. Where devices are indicated with the suffix "H", mount device with long axis horizontal.
 - F. Where devices are located with an adjacent "dot", mount 6" above counter top to centerline of device.
 - G. On exposed conduit systems provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.
 - H. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
 - I. Provide knockout closures to cap unused knockout holes where blanks have been removed.
 - J. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
 - K. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
 - L. Boxes for any conduit system shall not be secured to any suspended ceiling system, HVAC ductwork, or mechanical piping.
 - M. Provide junction and pull boxes for feeders and branch circuits where shown and where required by the NEC, regardless of whether boxes are shown or not.
 - N. Provide access doors or other approved means of access where junction boxes are concealed in wall and ceiling cavities.
 - O. Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Contracting Officer in writing where modifications or additional construction are required to maintain the partition or slab fire rating.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide wiring device Work as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical wiring devices required for the project include the following:
 - 1. Receptacles
 - 2. Switches
 - 3. Telephone outlets
 - 4. Wall Plates.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. General Electric Co.
 - 2. Harvey Hubbell, Inc.
 - 3. Leviton Mfg. Co., Inc.
 - 4. Lutron, Inc.
 - 5. Pass and Seymour, Inc.

6. Sierra Electric
 7. Slater Electric, Inc.
 8. Eagle
 9. Burndy.
- B. UL Label: All wiring devices shall be UL labeled.

PART 2 - PRODUCTS

2.1 FABRICATED DEVICES:

- A. General: Provide factory-fabricated wiring devices, in type, color, and electrical rating for the service indicated.
- B. Receptacles: Comply with NEMA Standard WD1 and as follows:
1. General-Duty: Provide simplex or duplex specification grade type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, side wired with screw type terminals, ivory molded phenolic compound, NEMA configuration as indicated. Device color shall be ivory for all areas except for the auditorium. Device color for the auditorium shall be selected by the Contracting Officer.
 - a. 20 amp, 125 volt grounded simplex NEMA #5-20R: Hubbell 5361-I.
 - b. 20 amp, 125 volt grounded duplex NEMA #5-20R: Hubbell 5362-I.
 - c. 20 amp, 125 volt grounded duplex NEMA #5-20R with integral ground fault interrupter and test button: Hubbell GF-5362-I.
 2. Heavy-Duty Simplex: Provide single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back wiring, black molded phenolic compound, NEMA configuration as indicated.
 - a. 30 amp, 125 volt grounded single NEMA #5-30R: Hubbell #9308 with #703 stainless steel plate.

- b. 30 amp, 250 volt, grounded, 3-wire, 2-pole NEMA #6-30R: Hubbell #9330 with #703 stainless steel coverplate or weatherproof coverplate, as required.
 - c. 20 amp, 125/250 volt, grounded, 4-wire, 3-pole NEMA #14-20R: Hubbell #8410 with #720 stainless steel coverplate.
- C. Switches: Comply with NEMA Standard WD1 and as follows: Provide specification grade flush rocker switches, with mounting yoke insulated from mechanism, equipped with plaster ears, white switch rocker, and side-wired screw terminals.
- 1. Single-pole, 120/277 volt, 20 amp switch: Hubbell 1221-I.
 - 2. Three-way, 120/277 volt, 20 amp switch: Hubbell 1223-I.
 - 3. Four-way, 120/277 volt, 20 amp switch: Hubbell 1224-I.
 - 4. Single-pole, 277 volt, 20 amp switch, red pilot light: Hubbell 1221-PL.
 - 5. Single-pole, momentary contact, two-circuit, three-position, center off: Hubbell 1387-I.
- D. Wall Box Dimmers: Provide self-contained, wall box mounted, linear slide, square-law dimmers with a positive OFF position at the end of travel. Dimmers shall operate continuously at rated load in an ambient temperature up to 40.C and with an input of 100 to 130 volts.
- 1. Single-pole, 120 volt, 1000 watt: Lutron #N-1000
 - 2. Single-pole, 120 volt, 1500 watt: Lutron #N-1500.

2.2 WIRING DEVICE ACCESSORIES:

- A. Wall Plates: Provide switch, duplex outlet, telephone and cable TV wall plates, with multi-gang cutouts as indicated, complete with metal screws for securing plates to devices. Screw heads shall be colored to match finish of plate. Wall plates shall possess the following additional construction features.
- B. Material and Finish:
- 1. Specification grade, stainless steel for general duty receptacles, switches, and telephone in finished areas.

2. Specification grade coverplates, weatherproof, Lexan fiberglass-reinforced, with gasket, for exterior and wet area receptacles and switches.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES:

- A. General: Install wiring devices where shown, in accordance with Manufacturer's written instructions, applicable requirements of NEC, and in accordance with recognized industry practices to ensure that products serve intended function. Delay installation of devices until wall construction and wiring is completed.
- B. Box Condition: Install receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, and similar matter.
- C. Alignment: Install all wiring devices plumb and aligned in the plane of the wall, floor, or ceiling in which they are installed.
- D. Switches: Install rocker switches on the strike side of doors as hung and in a uniform position so that the same direction will open and close the circuit throughout the project. Where more than one switch in the same location, install switches in a multi-gang box with a single coverplate.
- E. Receptacles: Install receptacles where indicated. Where splash-backs occur above counters, mount devices horizontally at 4 inches to receptacle centerline above splash-backs. All devices shall be installed complete with coverplates.
- F. Coverplates: Install plastic coverplates as indicated in paragraph 2.02 above.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

General: Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items that have been damaged, including those burned and scored by faulty plugs.

3.3 TESTING:

General: Prior to energization, check for continuity of circuits, for short circuits, and check grounding connections. After energization, check wiring devices to demonstrate proper operation and receptacles for correct polarization.

END OF SECTION

SECTION 16160

PANELBOARDS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide panelboard and enclosure Work, including cabinets, as shown, scheduled, indicated, and as specified.
- B. Types: The types of panelboards and enclosures required for the project include the following:
 - 1. Power distribution panelboards.
 - 2. Lighting and appliance panelboards.

1.3 QUALITY ASSURANCE:

- A. MANUFACTURERS: Provide products produced by one of the following:
 - 1. Siemens
 - 2. Cutler-Hammer, Inc.
 - 3. General Electric Co.
 - 4. Square D Co.
 - 5. Westinghouse Electric Corp.
- B. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL labeled.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Lighting and appliance panelboards shall be dead-front safety-type equipped with molded case circuit breakers as shown and scheduled. Power distribution panelboards shall be dead-front type equipped with fusible switches or circuit breakers as shown and scheduled.
- B. Busing Assembly: Panelboard and power distribution panelboard busing shall be tin-plated 55-percent conductivity aluminum, plated by the latest Alstan process. Bus structure and mains shall have ratings as shown and scheduled. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50.C rise above 40.C ambient. Heat rise test shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests. All bolted joint connections shall have at least two bolts per joint per phase. All bolted connections for aluminum bus having a yield strength of less than 20 KPSI shall have Belleville washers. Half lapped bus joint construction will not be acceptable. Furnish a bare uninsulated ground bus inside each panelboard enclosure. All two-section panelboards shall be connected with copper cable, with an ampacity meeting or exceeding the main bus ampacity.
- C. Circuit Breakers: Circuit breakers shall be of the molded case, thermal magnetic type equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other. Tripped indication shall be clearly shown by the breaker handle taking a position between ON and OFF. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers in all panelboards shall bolt-in. All 2-pole and 3-pole breakers shall have common trips.
 - 1. Provide panelboard circuit breakers with conventional interrupting capacity unless otherwise shown, but in no case less than the following symmetrical amperes RMS:

Voltage (volts)	Interrupting Capacity
120/208	22,000 AIC
 - 2. Ground fault interrupter (GFI) circuit breakers, where shown, shall be 5 ma ground fault trip and shall include a TEST button.
- D. Fusible Switches: Fusible switches shall be quick-make, quick-break type. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a

hinged cover for access to the fuses. Cover shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be overridden for testing fuses without interrupting service. The switches shall have padlocking provisions in the OFF position. Switches shall include positive pressure rejection type fuse clips for use with UL Class R fuses and be UL labeled for 200,000 AIC.

- E. Spaces: Where space for future breakers or switches is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers or switches, and panelboard busing shall be complete, including all required connectors.
- F. Integrated Equipment Rating: Each panelboard, as a complete unit, shall have a short-circuit rating equal to the interrupting rating of the weakest overcurrent device installed in the panelboard. Such ratings shall have been established by tests on similar panelboards with the circuit breakers or fusible switches installed.
- G. Panelboard Enclosures: Provide sheet steel enclosures, NEMA Type 1, minimum 16-gauge thickness, with multiple knockouts, unless shown otherwise. Provide doors with concealed hinges, spring-loaded door pulls, and flush lock and key, all panelboard enclosures keyed alike, equipped with interior circuit directory frame, card, and clear plastic covering for all lighting and appliance panelboards. Provide painted grey enamel finish over a rust inhibitor. Enclosure shall be for recessed or surface mounting as shown. Enclosures shall be fabricated by the same Manufacturer as panelboards to be enclosed.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES:

- A. General: Install panelboards and enclosures, as shown, including electrical connections, in accordance with the Manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Coordination: Coordinate installation of panelboards and enclosures with cable and raceways installation Work.
- C. Anchoring: Anchor enclosures firmly to walls and structural surfaces ensuring that they are permanently and mechanically secured.
- D. Mounting: Install panels on walls such that top of panelboard enclosure is 6'-6" above finished floor.

- E. Enclosures: Provide NEMA type enclosure as required for the environment in which the panelboard is located. Typically, indoor installations shall be provided with NEMA 1 enclosures; outdoor installations shall be provided with NEMA 3R enclosures.
- F. Concrete Pads: Install each floor-mounted power distribution panelboard on a 4-inch reinforced concrete housekeeping pad. The housekeeping pad shall extend 3 inches beyond the housing of the distribution panel, unless otherwise shown. Furnish the exact position of any block-outs, dimensions, and location of the housekeeping pads in time to prevent delay of the concrete Work.
- G. Directory Card: Type the enclosure's circuit directory card upon completion of Work.
- H. Fuses: Install fuses, of the ratings and class shown, in each power distribution and motor control panelboard.
- I. Circuit Arrangement: Branch circuit connections to 3-phase lighting and appliance panelboards shall be arranged such that when two or three circuits are run with a common neutral, each circuit shall be connected to a different phase unless otherwise shown. Branch circuits shall be connected to the circuit breakers in the lighting and appliance panelboard to provide the best possible phase balance, unless otherwise shown.

3.2 TESTING:

General: Prior to energization, check for continuity of circuits and for short circuits.

END OF SECTION

SECTION 16425

SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide switchboard Work as shown, scheduled, indicated, and as specified.
- B. Types: The types of switchboards required for the project include power distribution switchboards.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. General Electric Co.
 - 2. Siemens
 - 3. Square D Co.
 - 4. Westinghouse Electric Corp.
- B. UL Labels: Provide switchboards which have been UL labeled for service entrance, and meet applicable requirements of UL 891.
- C. NEMA Compliance: Comply with National Electrical Manufacturers' Association (NEMA) Standard PB2, "Dead-Front Distribution Switchboards".

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

General: Except as otherwise indicated, provide switchboard Manufacturer's standard materials and components as indicated by his published product information, designed and constructed as recommended by the Manufacturer, and as required for a complete installation.

2.2 DEAD-FRONT DISTRIBUTION SWITCHBOARDS:

- A. General: Provide a factory-assembled, dead-front, NEMA 1 construction, metal-enclosed, self-supporting switchboard of the voltage, phase, ampacity, and short circuit bracing shown.
1. Switchboard shall consist of the required number of front and rear aligned vertical sections bolted together to form one metal-enclosed rigid switchboard. The switchboard shall be designed as a free-standing board with front and rear access.
 2. Switchboard shall include all protective devices and equipment as shown with necessary interconnections, instrumentation, and control wiring. Small wiring, necessary fuse blocks, and terminal blocks within the switchboard shall be furnished. All groups of control wires leaving the switchboard shall be furnished with terminal blocks with suitable numbering strips.
- B. Enclosure Construction: The switchboard framework shall be fabricated on a die-formed steel base, or base assembly, consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework shall be formed code gauge steel, rigidly welded and bolted together to support all coverplates, busing, and component devices during shipment and installation.
1. Each switchboard section shall have an open bottom and individually removable top plates for installation and termination of conduit. Top and bottom conduit areas shall be clearly shown and dimensioned on the shop drawings. All front plates used for mounting meters, selector switches, or other front-mounted devices shall be hinged, with all wiring installed and laced, and with flexibility at the hinged side. All closure plates shall be screw removable and small enough for easy handling by one man. Furnish bus stubs, factory-fabricated with unit, on top of switchboard for proper entrances and exits of busduct.
 2. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to prevent moisture entrance and rust formation under the paint film. The paint finish shall be gray enamel over a

rust-inhibiting phosphate primer.

- C. Busing: The switchboard busing shall be tin-plated aluminum, plated by the latest Alstan process, and of sufficient cross-sectional area to continuously conduct rated full load current with a maximum temperature rise of 50 degrees C above an ambient temperature of 40 degrees C.
1. The bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard. The main horizontal bus bars between Sections shall be located on the back of the switchboard to permit maximum available conduit area. The horizontal main bus bar supports, connections, and joints shall be bolted or welded, as required, so as not to require periodic maintenance. All bolted joint connections shall have at least two bolts per joint per phase. (All bolted connections for aluminum bus having a yield strength of less than 20 KPSI shall have Belleville washers). Half lapped bus joint construction will not be acceptable.
 2. Buses shall be arranged A-B-C, left-to-right, top-to-bottom, and front-to-rear throughout. A ground bus shall be secured to each vertical section structure and extend the entire length of the switchboard.
 3. The main horizontal bus and incoming line shall be isolated and insulated from outgoing busing and cable connections.
 4. Where "space" is shown on one line drawings, space shall be bused for installation of future switches sized as shown.
- D. Integrated Equipment Rating: The switchboard, as a complete unit, shall be given a single integrated equipment rating by the Manufacturer. The integrated equipment short-circuit rating shall certify that all equipment is capable of withstanding the stresses of a fault equal to that shown in RMS symmetrical amperes. Such ratings shall have been established by actual tests by the Manufacturer on similar equipment construction as the subject switchboard. This test data shall be available and furnished, if requested, with or before the submittal of shop drawings.
- E. Indicating Instruments: Switchboard instrumentation shall include 1 percent accuracy, switchboard class, 250 degrees scale ammeter, voltmeter, with selector switches, and necessary current and potential transformers for reading on main bus, and KW demand meter (resettable) and KWHR meter. Selector switches shall include an OFF position in addition to line and phase voltage and current positions.
- F. Overcurrent Devices:
1. Fusible Switches: Main Device switches 800 amperes and larger shall be bolted pressure fusible switches with ratings as shown. Each switch shall be

enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Cover shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be overridden for testing fuses without interrupting service. Switches shall have padlocking provisions in the OFF position. Switches shall be UL labeled for 200,000 AIC.

2. Fusible Switches: Branch switches 800 amperes and smaller shall be quick-make, quick-break fusible switches with ratings as shown. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Cover shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be overridden for testing fuses without interrupting service. Switches shall have padlocking provisions in the OFF position. Switches shall include positive pressure rejection type fuse clips for use with UL Class R fuses and be UL labeled for 200,000 AIC.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHBOARDS:

- A. General: Install switchboards where shown, in accordance with the Manufacturer's written instructions, and recognized industry practices to ensure that the switchboards comply with the requirements and serve the intended purposes.
- B. Standards: Comply with the requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation", for installation of switchboards.
- C. Tightness: Torque bus connections and tighten mechanical fasteners.
- D. Fuses: Install fuses, of the ratings shown, in each switchboard.
- E. Concrete Pads: Install switchboards on a 4-inch reinforced concrete housekeeping pad. The housekeeping pad shall extend 3 inches beyond the housing of the switchboard unless shown otherwise. Switchboard shall be bolted to the housekeeping pad using 3/8-inch minimum galvanized bolts and anchors on 30-inch maximum centers. Furnish the exact position of any block outs, dimensions, and location of the housekeeping pads in a timely manner so as to prevent delay of the concrete Work.
- F. Adjustment: Adjust operating mechanisms for free mechanical movement.

3.2 TESTING:

- A. Pre-Energization Checks: Prior to energization, check switchboards for continuity of circuits and for short circuits.
- B. Switchboard Insulation Resistance Test: Each switchboard bus shall have its insulation resistance tested after the installation is complete except for line and load side connections. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 VDC. Resistance shall be measured from phase-to-phase and from phase-to-ground.
- C. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit 4 copies of certified test results to Contracting Officer for review. Test reports shall include switchboard tested, date and time of test, relative humidity, temperature, and weather conditions.
- D. Thermographic Testing: Refer to Section 16010 for thermographic testing.

END OF SECTION

SECTION 16440

SAFETY AND DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide safety and disconnect switch Work as shown, scheduled, indicated, and as specified.
- B. Types: The types of safety and disconnect switches required for the project include the following:
 - 1. Equipment disconnects
 - 2. Motor-circuit disconnects.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. Cutler-Hammer, Inc.
 - 2. General Electric Co.
 - 3. Seimens
 - 4. Square D Company
 - 5. Westinghouse Electric Corp.
- B. NEMA Compliance: Comply with National Electrical Manufacturers' Association (NEMA) Standard KS1.
- C. UL Approved: Safety and disconnect switches must have UL approval and bear the

UL label.

PART 2 - PRODUCTS

2.1 MATERIAL:

- A. General: Provide heavy-duty type, dead-front, sheet steel-enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit in which they are installed. Safety switches used as motor disconnects shall be horsepower rated for the motor served.
- B. Switch Mechanism:
 - 1. Safety switches shall be quick-make, quick-break type with permanently attached arc suppressors and constructed such that switchblades are visible in the OFF position with the door open. The operating handle shall be an integral part of the box, not of the cover. Switch shall have provision to padlock in the OFF position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the ON position, or closing of the switch mechanism when the switch door is open.
 - 2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. All current-carrying parts shall be constructed of high-conductivity copper with silver-plated switch contacts. Lugs shall be suitable for copper cable and front removable.
- C. Fusing: Provide fusible safety switches where indicated. Fuse clips shall be positive pressure rejection-type fuse clips suitable for use with UL Class R fuses.
- D. Neutral: Provide safety switches with number of switched poles as indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch.
- E. Enclosures:
 - 1. All safety switches installed in indoor locations shall be NEMA 1 general purpose enclosures unless otherwise shown.
 - 2. Safety switches installed in exterior locations shall be NEMA 3R (raintight) unless otherwise shown.

PART 3 - EXECUTION

3.1 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES:

- A. General: Install safety and disconnect switches where shown, in accordance with the Manufacturer's written instructions, the applicable requirements of the NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Location: Provide safety switches where shown and at each motor which is out of sight of, or greater than 50 feet from, the switch or panel from which the motor circuit is fed.
- C. Supports: Provide all safety and disconnect switches with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.
- D. Disconnect Switches: Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position unless otherwise indicated.
- E. Coordination: Coordinate safety and disconnect switch installation work with electrical raceway and cable work as necessary for proper interface.

3.2 TESTING:

General: Prior to energization, check for continuity of circuits and for short circuits.

END OF SECTION

SECTION 16450

ELECTRICAL GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide electrical service and equipment grounding as shown, scheduled, indicated, and as specified.
- B. Types: The types of electrical service and equipment grounding specified in this Section include, but are not necessarily limited to, grounding all equipment and devices shown, and as required by the National Electrical Code (NEC), the local electrical inspection department, and the Power Company.

1.03 QUALITY ASSURANCE:

- A. NEC Compliance: Comply with Article 250 of the NEC (NFPA 70) for grounding.
- B. Approval: All grounding shall be in accordance with the requirements of, and shall be subject to the approval of the local electrical inspection department.
- C. UL Label: All grounding products shall be UL labeled.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical grounding connection, provide a complete assembly of materials to construct a completely grounded electrical system.
- B. Ground Rods: Ground rods shall be 3/4" diameter and a minimum of 10-feet long with steel core and copper jacket. Ground rods shall be as manufactured by

Copperweld.

- C. Raceways: Raceways for grounding conductors shall be as specified in Sections 16110 and 16130.
- D. Cable, Wire and Connectors: Grounding cable, wire, and connectors shall be as specified in Section 16120.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING:

- A. General: Install grounding connections as shown and specified, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Grounding Electrode System: The main switchboard neutral and ground buss shall be connected to the incoming cold water piping system to the building on the street side of the building water meter. The main grounding conductor shall be sized as shown, and shall be run in conduit. The cold water pipe ground shall be supplemented as required by NEC, Article 250 H, and as required by the local inspection department.
- C. Building Equipment Grounding System: The building equipment grounding system shall consist of the ground wire, and electrically continuous metallic conduit system as shown. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems that are electrically isolated shall be bonded to the equipment grounding system with a flexible bonding jumper.
- D. System Neutral: The system neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building grounding system throughout the building. The neutral of separately derived systems shall be grounded at one point as specified herein below.
- E. Feeders: Feeders to all major points of distribution and major items of equipment shall carry a grounding conductor, sized in accordance with Article 250 of the NEC.
- F. Miscellaneous: Provide bonding and grounding wires run in conduit and sized per the NEC in accordance with the local electrical inspection department and the NEC. Metallic piping and duct systems that enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.

- G. Continuity: Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquid-tight flexible metal and flexible metal conduit, and all other non-electrically continuous raceway fittings.
- H. Main Conductors: All main grounding conductors shall be stranded copper conductors, sized as shown, and run in a suitable raceway. All main grounding conductors shall be continuous without joints or splices over their entire length.
- I. Special Grounding: Provide special grounding systems where shown.
- J. Separately Derived System Grounding: Bond the case and neutral of each separately derived system (generator set) directly to the nearest available effectively grounded structural metal member of the structure, the nearest available effectively grounded metal water pipe, in accordance with the local electrical inspection department. Flexible conduit shall not be used as a ground path to a transformer.
- K. Telephone Equipment Grounding: Provide a ground conductor from the telephone service equipment to the building grounding system as required by the local Telephone Company.
- L. Fluorescent Fixtures: Carefully and securely ground all fluorescent fixture bodies to the conduit grounding system.
- M. Receptacles: Ground all grounding-type receptacles with ground clips, properly installed using a separate ground wire.
- N. Motor Frames: Ground the frame of each motor with a properly sized separate ground wire around the liquid-tight flexible conduit.

3.2 COORDINATION:

General: Coordinate installation of grounding connections for equipment with equipment installation Work.

3.3 TESTING:

- A. Ground Resistance Test: Perform a ground resistance test for comparison to future inspection and testing data by the Contracting Officer. Overall system resistance shall not exceed 25 ohms. Test shall be performed using a Biddle Megger Earth Tester or equivalent test instrument. The test shall not be performed immediately following wet weather conditions.

- B. Submittals: Contractor shall furnish all instruments and personnel required for tests. Submit two copies of certified test results for Contracting Officer's record and submit four copies of certified test results to Contracting Officer for review. Test reports shall include date and time of tests, relative humidity, temperature, and weather conditions.

END OF SECTION

SECTION 16475

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of fuse Work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of fuses required for the project include the following: 600-volt and less current-limiting fuses

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. Bussmann Mfg.
 - 2. Chase Shawmut Co.
- B. Coordination: All fuses shall, to the maximum extent possible, be from the same Manufacturer to facilitate positive selective coordination of protective devices.

PART 2 - PRODUCTS

2.1 CURRENT-LIMITING FUSES - 600 VOLTS AND LESS:

- A. General: Provide 200,000 amperes interrupting capacity (AIC) current-limiting fuses of the current ratings shown and with a voltage rating equal to or greater than the voltage at the point of application.

- B. Types:
1. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 600 amperes or less, shall be UL Class RK1 dual-element, time-delay fuses, unless otherwise shown.
 2. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 601 to 4000 amperes, shall be UL Class L time delay fuses, unless otherwise shown.
 3. Fuses in circuits supplying other than motor loads, 600 amperes or less, shall be UL Class RK1 dual-element, time-delay fuses, unless otherwise shown.
- C. Lighting Fixture Protection: All fluorescent and HID ballasts shall be protected on the supply side with a Bussmann-type GLR fuse in a Bussmann-type HLR in-line fuse holder.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install fuses in fuse holders immediately prior to energization of the circuit in which the fuses are installed. Fuses shall not be installed and shipped with equipment.
- B. Labels: Place fuse identification labels, showing fuse size and type installed, inside the cover of each switch.

END OF SECTION

SECTION 16480
MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of motor starter Work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of motor starters required for the project include the following:
 - 1. Individual motor starters
 - 2. Combination motor starters
 - 3. Manual motor starters

1.3 QUALITY ASSURANCE:

Manufacturers: Provide products produced by one of the following:

- A. Siemens
- B. General Electric Co.
- C. Square D Company
- D. Westinghouse Electric Corp.

PART 2 - PRODUCTS:

2.1 INDIVIDUAL MOTOR STARTERS:

- A. General: Individual motor starters shall consist of an integrally mounted, magnetic, full-voltage, non-reversing (FVNR), or two-speed, two-winding (2S-2W) starter in a heavy-duty type, dead front, sheet steel enclosure, and surface-mounted. Size and number of poles shall be as shown and required by equipment served. All starters shall be constructed and tested in accordance with latest NEMA standards.
- B. Contacts: Magnetic starter contacts shall be solid silver cadmium oxide alloy, and shall not require any filing, dressing, or cleaning throughout the life of the starter.
- C. Operating Coils: Operating coils shall be 120 volts, and be pressure molded and designed so that accidental exposure to excessive voltage up to 480 volts will not damage the coil. The starter design shall also be such that when a coil fails due to an over-voltage condition, the starter shall definitely open, and shall not freeze in the closed position.
- D. Overload Relays: All starters shall have manual-reset, trip-free overload relays in each phase conductor. Three-phase FVNR starter shall have three overload relays. Single-phase FVNR starters shall have an overload relay in each ungrounded conductor. Two-speed, full voltage magnetic starters shall have overload relays in all six control legs. Overload relays shall not be field-convertible from manual to automatic reset.
- E. Pilot Lights: Provide RUNNING pilot lights for all motor starters. Furnish additional pilot lights for motor starters as shown. Provide FAST and SLOW pilot lights for all two-speed starters. Pilot lights shall be mounted in the starter enclosure cover. Pilot lights shall be operated from an interlock on the motor starter, and shall not be wired across the operating coil.
- F. Controls: Provide starters with HAND-OFF-AUTOMATIC switches, or START-STOP pushbuttons as shown or required. Provide for FAST-SLOW speed selection from HVAC control system for all two-speed starters. All two-speed starters shall have deceleration relays between fast and slow speeds. Coordinate motor starter controls with the requirements of Division 15. Motor starter controls shall be mounted in the starter enclosure cover.
- G. Control Power: A single-phase control power transformer shall be included integrally with each starter for 120-volt control power. The primary shall be connected to the line side of the motor starter; the secondary shall have one leg fused and one leg grounded. Arrange transformer terminals so that wiring to terminals will not be located above the transformer.
- H. Auxiliary Contacts: Each starter shall have one normally open and one normally closed convertible auxiliary contact in addition to the number of contacts required

for the "holding interlock" and control wiring. In addition, it shall be possible to field-install one or more additional auxiliary contacts without removing existing wiring, or removing the starter from its enclosure.

- I. Power Monitor: Provide a 3-phase power monitor for each motor starter serving a motor of 25 hp or greater. Monitor relay shall drop out upon loss of any phase, under-voltage on any or all phases, or phase reversal from A-B-C sequence. Relay shall be adjustable for trip range and shall automatically reset upon correction of trouble.
- J. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for: connection of power supply conductors to switch line side terminals; motor leads to the starter load side terminals; and control conductors to holding coil terminals.
- K. Enclosures: All motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.

2.2 COMBINATION MOTOR STARTERS:

- A. General: Combination motor starters shall consist of an integrally mounted magnetic starter and a fusible disconnect switch in a heavy-duty type, dead-front, sheet steel NEMA 1 enclosure, surface mounted. Size and number of poles shall be as shown and required by equipment served. Combination motor starters shall be as specified for individual motor starters in Paragraph 2.01 except as modified herein.
- B. Disconnect Switch: Disconnect switch shall be as specified in Section 16440.
- C. Unit Wiring: Unit shall be completely pre-wired to terminals to eliminate any interior field wiring except for: connection of power supply conductors to switch line side terminals, motor leads to the starter load side terminals, and control conductors to holding coil terminals.
- D. Enclosures: All combination motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.

2.3 MANUAL MOTOR STARTERS:

- A. General: Manual motor starters shall consist of an integral starter and overload protection in a common enclosure, surface mounted. Size and number of poles shall be as shown and required by equipment served. Furnish pilot light as indicated.
- B. Manual Motor Starter: Manual motor starter with overload protection, 1 hp

maximum, 115 or 230 volts; General Electric Model No. CR101Y1, 1-pole, CR101H1, 2-pole; General Electric Model No. CR101Y11, 1-pole, with pilot light; CR101H11, 2-pole; with pilot light.

- C. Enclosures: All manual motor starter enclosures shall be NEMA 1, general purpose enclosures, unless shown otherwise.
- D. Switch: For self-protected motors where one-pole toggle motor control switch is allowed, the switch shall be as specified for toggle switches in Section 16140.

PART 3 - EXECUTION:

3.1 INSTALLATION OF MOTOR STARTERS:

- A. General: Install motor starters where shown, in accordance with the Manufacturer's written instructions, the applicable requirements of the NEC and NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Overloads: Install overload heaters in each motor starter. Heater ratings shall be based on actual motor nameplate full load amps.
- C. Coordination: Motor starters shall be provided to properly coordinate with motors as furnished by Division 15. Motor starter controls shall be provided to properly coordinate with controls specified in Division 15.
- D. Supports: Provide all individual and combination motor starters with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Starters shall not be supported by conduit alone. Where motor starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas. Manual motor starters shall be installed plumb and aligned in the plane of the wall in which they are installed.

3.2 TESTING:

- A. Pre-Energization Check: Check motor starters for continuity of circuits and for short circuits.
- B. Post Hook-Up Test: Subsequent to wire and cable hook-ups, energize motor starter and demonstrate satisfactory functioning.

END OF SECTION

SECTION 16500

LIGHTING FIXTURES AND LAMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of lighting fixture Work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of lighting fixtures required for the project include the following:
 - 1. Fluorescent type fixtures.
 - 2. High-intensity-discharge (HID) type fixtures:
 - a. Mercury-vapor type fixtures
 - b. Metal-halide type fixtures
 - c. High-pressure-sodium type fixtures.
 - 3. Incandescent type fixtures.
- C. Applications: The applications of lighting fixtures required for the project include the following:
 - 1. General lighting
 - 2. Emergency lighting
 - 3. Outdoor area lighting.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by manufacturers as shown or

scheduled or equal to, for each type of lighting fixture. Provide products produced by one of the following for ballasts and lamps:

1. Ballast Manufacturers:
 - a. Advance Transformer Co.
 - b. Universal Manufacturing Co.
 - c. General Electric Co.
 2. Lamps:
 - a. General Electric Co.
 - b. GTE Sylvania
 - c. North American Phillips
 - d. Osram
- B. CBM Label: Provide fluorescent ballasts which comply with Certified Ballast Manufacturers' Association (CBM) standards and carry the CBM mark on the label.
- C. UL Standards: Lighting fixtures shall conform to all applicable UL standards, and shall be UL labeled.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: Provide lighting fixtures, of the size, type, and rating indicated, complete with, but not necessarily limited to, lamps, lampholders, reflectors, ballasts, starters, and wiring.
- B. Fixture Types:
1. Fluorescent Fixtures: Provide fluorescent fixtures complete with lamps and ballasts.
 - a. Provide fluorescent fixtures with G.E. ALF 216 or Leviton 13180 Series lamp sockets, or equal by H&H or Bryant.
 - b. Fluorescent fixture lenses, where required, shall be extruded virgin acrylic, prismatic type, nominal 0.125-inch thick.
 - c. Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended

by the Manufacturer for continuous row installation.

2. HID Fixtures: Provide HID fixtures complete with lamps and ballasts.
 - a. Provide a shield below the lamp to prevent glass, if a lamp breaks, from falling to the floor.
 - b. Protect HID lighting fixtures on the line side of the ballast with fuse and holder. Holder shall be mounted in a protected location convenient for changing fuses, or be an in-line waterproof holder. Size and type of fuse shall be as recommended by ballast Manufacturer.
 3. Incandescent Fixtures: Provide incandescent fixtures complete with lamps. Provide recessed incandescent fixtures with trim rings compatible with the ceiling material where fixture is to be installed.
 4. Exit Signs: The exit lighting fixtures shall meet the requirements of Federal, State, and Local codes.
- C. Fluorescent (interior) Ballasts : Ballasts for fluorescent fixtures shall be electronic and shall be UL, CBM and ETL approved. Ballasts shall be for 120 volt operation.
- D. Ballasts - HID: Provide high power factor, constant wattage, auto-transformer ballasts with a -20°F temperature rating. Use ballasts for lamps up to 250 watts with a "B" sound rating. Use ballasts for lamps 400 watts and larger with a "C" sound rating.
- E. Voltage: Ballasts for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 volts to 130 volts. Ballasts for use on 277 volt systems shall be suitable and guaranteed for a voltage range of 225 volts to 290 volts.
- F. Lamps: Provide lamps of the wattage, type, color, and reflector lamps with type of beams indicated, as shown, and scheduled. Provide extended service (130V) lamps that are inside frosted, where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture Manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the

requirements and serve the intended purposes. Fixtures shall exactly fit the type of ceiling system scheduled for the space.

- B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of interior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".
- C. Attachment: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports for all recessed ceiling-mounted HID lighting fixtures. Check to ensure that solid pendant fixtures are plumb.
- D. Refer to reflected ceiling Plan for exact location of all ceiling mounted fixtures. Clarify any discrepancy prior to rough-in.

3.2 TESTING:

- A. General: Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units, and proceed with retesting.
- B. Lamps: Install all new incandescent lamps just prior to final inspection. Fluorescent and mercury vapor lamps may be utilized in the final finishing of the building. Replace gaseous discharge lamps that are defective, show discolorations, or have exceeded more than 1/3 of their rated life, as per construction inspector's records, with new lamps for final inspection.
- C. Pre-Inspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts, and lamp and test all fixtures for electrical and mechanical operation. Any fixtures, or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed, and replaced with properly protected metal parts.

END OF SECTION

SECTION 16720

COMBINATION FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF THE WORK:

General:

- A. The extent of combination fire alarm system Work is as shown and scheduled and includes, but is not limited to, providing a system as described herein.
- B. The system described herein is a new system. New materials shall consist of, but not be limited to, pull stations, heat detectors, smoke detectors, duct detectors, sampling tubes, strobes, horns, relays, RF transmitter and conduit and wiring. The system shall be installed by a qualified factory trained technician, and submittals shall be accompanied by a document from the equipment manufacturer that the submitted equipment installer is so trained.
- C. The system specified is based on the equipment named in each system description and compatible to Base-wide system.
 - 1. A RF transmitter shall be installed adjacent to the main fire alarm system panel, which shall be Monaco "M1" panel, model "P/N #226-501-00 type", or equal, compatible with Base-wide system.
 - 2. All references to main panel and device model numbers and other pertinent information is intended to establish the standards of performance, quality and appearance that must be met (MONACO).
- D. Equipment of other Manufacturers will be considered if, in the opinion of the Contracting Officer, the standards of compatibility, performance, quality and appearance are equal to that specified below.
- E. Any equipment proposed as equal to that specified shall be so proven by the Contractor, who shall submit to the Contracting Officer the Manufacturer's name,

model numbers and two copies of working drawings, and engineering data sheet covering the substitute material.

- F. All components and the system as a whole shall conform to the applicable standards. All work in conjunction with this installation shall meet the provisions of the National Fire Code, NFPA and any applicable local codes.
- G. The Contractor shall furnish five copies of illustrations, specifications and engineering data sheets of the equipment items and a block diagram of the system proposed to be furnished under these Specifications.
- H. The Contractor shall furnish three sets of instruction material requisite for the proper operation of the equipment.
- I. The Contractor shall guarantee the new materials and equipment to be free from defective material and workmanship for a period of one year from date of installation unless damage is caused by accident, abuse, improper operation or neglect. Maintenance, pursuant to this guarantee, shall be provided by the Contractor during normal working hours at no expense. The Contractor shall also provide a one year guarantee for the entire and complete system, including new and existing materials, equipment and devices. This guarantee shall be included in the Work, at no additional cost above the basic proposal for the Work.
- J. The Contractor shall show satisfactory evidence that he maintains a service organization capable of furnishing adequate inspection and service to the equipment and shall be prepared to offer a service contract for the maintenance of the system after the guarantee period up to an additional four years.
- K. Wiring: The Contractor shall furnish and install, in accordance with the Manufacturer's instructions, all conduit and outlet boxes required for the erection of a complete system described herein and as shown on the Drawings. All wiring shall be in a suitable raceway system and shall meet the requirements of all national, state and local electrical and fire codes. The sizes of wires shall be those specified by the Manufacturer. All wires shall be color-coded and tagged at all junction points and shall test free from grounds or crosses between conductors. Final connections between equipment and the wiring system shall be made under the supervision of a factory trained service representative of the Manufacturer.
- L. Where device or equipment numbers are indicated, they are for reference as to standards. Quantities shown on associated prints and riser diagrams are to be considered accurate. If local codes or NFPA Standards require additional devices with respect to count and location, the larger count will be supplied as part of the basic Work at no additional cost.

1.3 SCOPE AND RELATED DOCUMENTS:

- A. The Work covered by this Section of the Specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the Fire Alarm System as shown on the Drawings and as herein specified.
- B. The requirements of the conditions of the contract supplementary conditions and general requirements, apply to the Work specified in this Section.
- C. The complete installation shall conform to the applicable sections of NFPA-72, local code requirements, and the National Electrical Code with particular attention to Article 760.
- D. The Work covered by this Section of the Specifications shall be coordinated with the related Work as specified elsewhere under the project Specifications.

1.4 QUALITY ASSURANCE:

The system controls shall be UL listed for Power Limited Applications and all circuits must be marked in accordance with NEC article 760-23.

1.5 GENERAL:

- A. Furnish and install a complete fire alarm system as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition. Include sufficient control panel annunciator, RF transmitter, manual stations, automatic fire detectors, smoke detectors, alarm indicating appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. All peripheral devices shall be the standard product of a single Manufacturer and shall display the Manufacturer's name on each component. Any catalog numbers specified under this section are those of MONACO and constitute the type, product quality, material, and desired operating features.

1.6 SYSTEM OPERATION:

- A. Fire Alarm: Actuation of any alarm initiating device shall initiate the following:
 - 1. All audible annunciators to sound the fire alerting tone or trouble alarm by zone.

2. All visual alarms to flash or remain steadily on until system is cleared.
 3. Provide signals to the mechanical controls to shut down or re-route air handling systems to prevent the recirculation of smoke, IAW NFPA..
 4. Sufficient power for simultaneous operation of all signal and annunciation functions.
 5. Provide RF transmitter to signal central base monitoring system upon activation of any device in the system.
- B. The system panel shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with five (5) minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

PART 2 - PRODUCTS

- A. Description of Work
1. The contractor shall furnish a fire detection alarm system as indicated on the drawings. It shall meet requirements of power limited fire protection signaling circuits of Part C of Article 760 of the National Electrical Code NFPA 70. The system shall include but not be limited to all control panels, power supplies, initiating devices and accessories required to provide a complete operating fire alarm system.
 2. All new fire alarm equipment shall be labeled with the same manufacturer's name to assure the integration of the complete system. Mixing systems will not be approved.
 3. All equipment, devices, cable, etc., shall be listed by the Underwriters Laboratories Inc. and/or approved by Factory Mutual.
 4. The system shall comply with the appropriate provisions of NFPA 72 and Life Safety Code 101.
 5. The system supplier/installer shall be a factory authorized distributor and installer and shall stock sufficient spare parts to properly maintain the system.

B. System Operation

1. The operation of a manual station or activation of any smoke detector or heat detector device shall cause the alarm signals to sound throughout the facility and actuate a RF transmitter to alert the central monitoring system.
2. System shall also report zoned trouble alarm and include FACP trouble.

C. Materials

1. The Contractor shall furnish a 12 zone panel. The panel shall be expandable to 16 zones, U.L. listed, and shall have a secondary power supply consisting of a rechargeable gel cell battery and charging circuitry. This unit shall be flush mounted with a dead front door with lock. The control panel shall be MONACO M-1 #226-501-00 and shall be provided with any modules or features necessary to satisfy the intent of the plans or the specifications.
2. Smoke detectors, ionization type, shall be provided with visual alarm indicator and auxiliary contacts where required. MONACO #723-337-01.
3. Manual stations shall be non-coded, double action, MONACO P/N #708-014-00, (without glass rod).
4. Horn/Strobe units shall be 24 VDC devices; semi-flush mounted, and is U.L. listed. Horn shall be MONACO P/N #585-022-00 (Flush) or #585-020-00 (Semi-Flush).
5. Duct Detector shall be photo-electric type with auxiliary relay contacts, remote LED annunciator and 97" sampling tube, MONACO P/N #723-329-00.
6. Fixed Temperature and/or rate of rise heat detectors, MONACO P/N #721-102-ME, #721-401-ME, #721-403-ME.
7. One Class B general alarm signal circuit shall be provided in the control panel for horns. One Class B signal circuit shall be provided in the control panel for strobes.
8. Where shown on the plans, provide and install the Fire Alarm Control Panel. Construction shall be modular with solid state, microprocessor based electronics. All visual indicators shall be high contrast, LED type. The control panel shall be a MONACO M-1 or VULCAN -1.
9. All circuits requiring system operating power shall be 24VDC and shall be individually fused at the Control Panel.

PART 3 - EXECUTION

3.1 Installation:

- A. The installation of equipment and devices shall be as shown on the drawings and in strict compliance with the manufacturer's recommendations and NFPA Standards.
- B. Wiring shall be in conduit and meet all codes, both state, local, and NFPA.
- C. All circuits, J-boxes and terminal boxes will be marked "Fire Alarm". All wiring in terminal boxes will be neatly combed and fastened and will be marked as to function.
- D. Provide all equipment, wiring, conduit and outlet boxes as required or as shown on plans for the erection of a complete and operating system in accordance with applicable local, state and national codes, the manufacturer's recommendations, and these Plans and Specifications. All wiring shall be in a completely separate conduit system. Color code shall be used throughout. All J-boxes shall have the label "Fire Alarm" attached.
- E. The Manufacturer's authorized representative shall provide supervision of final system panel connections, perform a complete functional test of the system and submit a written report to the Contractor attesting to the proper operation of the system.
- F. All equipment and wiring shall be guaranteed against defects in materials and workmanship for a one year period from the start-up and beneficial use of the system. Warranty service for the equipment shall be provided by the Manufacturer's factory trained representative during normal working hours, Monday through Friday excluding holidays. Emergency service provided at times other than as stipulated above shall be available from the same source at additional cost.
- G. Upon satisfactory completion of system test, the Manufacturer's representative shall present a proposal to provide semi-annual inspection and tests of the system.
- H. Upon completion of the installation, the Contractor shall furnish the Contracting Officer with a copy of the Manufacturer's representative, a signed written statement attesting that all system equipment was installed in accordance with wiring diagrams, instructions and directions provided to the Contractor by the Manufacturer.

- I. The Contractor shall conduct a training session for the operating personnel. The training session shall include "hands on" practices and simulation of different alarm conditions. Maintenance and upkeep of equipment shall be addressed.

- J. Contractor shall provide spare parts of the following as minimal:
 - 1. (5) each spare fuses of each type/size W/I system.
 - 2. (2) each Smoke Detectors, each type/style installed.
 - 3. (2) each Heat Detectors, each type/style installed.
 - 4. (2) sets of spare batteries for FACP and/or transmitter.
 - 5. (2) each spare LED's of each type W/I system (FACP Items).
 - 6. (5) each spare bulbs of each type W/I system.
 - 7. (2) each spare sprinkler heads of each type W/I system.
 - 8. (2) each spare Key sets for any lockable panels.

END OF SECTION

SECTION 16740
TELEPHONE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The conditions of the Contract and applicable requirements of Division 1, Section 16010 and Section 16750 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide a complete telephone system as shown, scheduled, indicated, and as specified.
- B. Type: Provide 4 inch by 4 inch boxes, $\frac{3}{4}$ inch EMT conduit, telephone jack assemblies, Category 6 voice cable and 66 type termination blocks.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. Plywood: Provide $\frac{3}{4}$ " exterior grade plywood for terminal boards sized as shown and scheduled.
- B. Raceways: Provide $\frac{3}{4}$ " EMT from each telephone/LAN assembly to termination blocks.
- C. Wall-Type Telephone Outlets: Provide 2 Lucent T568B 6 Level jacks Comcode 107971574 color Ivory for telephone and 2 Lucent T568B 6 Level jacks Comcode 107971590 color gray for LAN, and 1 cover plate Lucent Comcode 106313646 color Ivory. (Refer to Section 16750 for LAN requirements).
- D. Telephone Voice Cable: Provide Category 6 Comcode 107987166, nonplenum, 24 gauge, PVC Jacket, 100 MHZ or above for each telephone jack (**DO NOT SPLIT PAIRS**). The Telephone voice cable shall meet Level 6 electrical and distance requirements of the EIA/TIA 586 (SP-1907B) Commercial Building Wiring Standard specification for horizontal UTP cables. Telephone cable color shall be Slate.

- E. Termination Blocks: Provide 66 type termination blocks.

PART 3 - EXECUTION

3.1 INSTALLATION OF TELEPHONE SYSTEM:

- A. General: Refer to Sections 16110 and 16130 for installation requirements of the telephone sleeve, and raceway system.
- B. Receptacles: Provide electrical receptacles mounted at five feet AFF at telephone terminal boards as shown.
- C. Misuse: Do not use telephone/LAN assembly EMT for temporary construction power wiring.
- D. Telephone Outlets: Telephone/LAN outlets shall be mounted at 12 inches above finished floor unless noted otherwise.
- E. Termination: A qualified technician using proper tools and equipment shall install and terminate all voice and LAN cables to both termination blocks and to telephone/LAN jacks assembly. All cables shall be properly labeled both at termination blocks and telephone/LAN jacks. Provide typed labels for exterior of cover plate at telephone/LAN assembly.
- F. Testing: All telephone voice cable shall be tested and certified for Gigabit Ethernet data or equivalent. Provide certified reports, which includes Line Mapping, DC Ohms, Impulse noise count, cable impedance, and cable length and ID number for each cable. All cables that fail testing shall be removed and replaced with new cable at no additional cost to the government.

END OF SECTION

SECTION 16750

LAN SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The conditions of the Contract and applicable requirements of Division 1, Section 16010 and Section 16740 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide a complete LAN system as shown, scheduled, indicated, and as specified.
- B. Type: Provide 4 inch by 4 inch boxes, $\frac{3}{4}$ inch EMT conduit, telephone/data jack assemblies, Level 6 data cable, and 110 type termination blocks.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. Plywood: Provide $\frac{3}{4}$ " exterior grade plywood for terminal boards sized as shown and scheduled.
- B. Raceways: Provide $\frac{3}{4}$ " EMT from each telephone/LAN jack assembly to termination blocks.
- C. Wall-Type Telephone Outlets: Provide 2 Lucent T568B 6 Level jacks Comcode 107971574 color Ivory for telephone and 2 Lucent T568B 6 Level jacks Comcode 107971590 color gray for LAN, and 1 cover plate Lucent Comcode 106313646 color Ivory. (Refer to Section 16740 for Telephone requirements).
- D. LAN Cable: Provide Category 6 Comcode 107987174, nonplenum, 24 gauge, PVC Jacket, 100 MHZ or above for each LAN jack (**DO NOT SPLIT PAIRS**). The LAN cable shall meet Level 6 electrical and distance requirements of the EIA/TIA 586 (SP-1907B) Commercial Building Wiring Standard specification for horizontal UTP cables. LAN cable color shall be blue.

- E. Termination Blocks: Provide Category 6 110 type termination blocks pre-wired with RJ45 on blocks.

PART 3 - EXECUTION

3.1 INSTALLATION OF TELEPHONE SYSTEM:

- A. General: Refer to Sections 16110 and 16130 for installation requirements of the telephone sleeve, and raceway system.
- B. Receptacles: Provide electrical receptacle mounted at five feet AFF at telephone terminal boards as shown.
- C. Misuse: Do not use telephone/LAN raceways for temporary construction power wiring.
- D. LAN Outlets: Telephone/LAN outlets shall be mounted at 12 inches above finished floor unless noted otherwise.
- E. Termination: A qualified technician using proper tools and equipment shall install and terminate all telephone voice and LAN cables to termination blocks and to telephone/LAN jacks. All cables shall be properly labeled at both the termination blocks and telephone/LAN jacks assembly. Provide typed labels for exterior of cover plate at telephone/LAN assembly.
- F. Testing: All LAN cable shall be tested and certified for Gigabit Ethernet data or equivalent. Provide certified reports, which includes Line Mapping, DC Ohms, Impulse noise count, cable impedance, and cable length and ID number for each cable. All cables that fail testing shall be removed and replace with new cable at no additional cost to the government.

END OF SECTION

SECTION 16816

CCTV SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The conditions of the Contract and applicable requirements of Division 1, Section 16010 governs this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide a complete CCTV system as shown, scheduled, indicated, and as specified.
- B. Type: Provide 4 inch by 4 inch boxes, $\frac{3}{4}$ inch EMT conduit, RG 6 Quad shielded cable and F-type connectors.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. Raceways: Provide telephone sleeve and raceway system as specified in Sections 16110 and 16130.
- B. Cable: Provide RG6 Quad shielded cable and F-type connectors.
- C. Cover Plates: Ivory Color, suited for use with F-type shielded cable connectors.

PART 3 - EXECUTION

3.1 INSTALLATION OF CCTV SYSTEM:

- A. General: Refer to Sections 16110 and 16130 for installation requirements of the sleeve, and raceway system.
- B. Cable installed shall be continuous; splicing or splitter are not acceptable.

END OF SECTION

SECTION 16910

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of electrical connections for equipment is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of electrical connections specified in this Section include, but are not necessarily limited to, the following connections:
 - 1. Motors
 - 2. Resistance heaters
 - 3. Motor starters
 - 4. Light fixtures
 - 5. Transformers, inverters, and rheostats
 - 6. Master units of communication, signal and alarm
 - 7. Line voltage temperature control equipment
- C. Work of Other Sections:
 - 1. Refer to Sections 16915 and 16920 for miscellaneous electrical controls, control wiring, and HVAC control system wiring.
 - 2. Refer to other Divisions of these Specifications for specific individual equipment electrical requirements.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products produced by one of the following:
 - 1. AMP, Inc.
 - 2. Burndy Corp.
 - 3. Cadweld
 - 4. General Electric Corp.
 - 5. Ideal Industries, Inc.
 - 6. Mac Products, Inc.
 - 7. Minnesota Mining and Mfg. Co.
 - 8. O. Z. Gedney Co.
 - 9. Thomas & Betts Co.
- B. UL Label: All products shall be UL labeled to the maximum extent possible.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide a complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations.
- B. Raceways: Refer to Sections 16110 and 16130.
- C. Cable, Wire, and Connectors: Refer to Section 16120.
- D. Terminals: Provide electrical terminals as instructed by the terminal Manufacturer for the intended application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment Manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.
- C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.
- D. Appearance: Prepare cables and wires by properly cutting and stripping covering, jacket, and insulation to ensure a uniform and neat appearance where cables and wires are terminated.
- E. Routing: Trim cables and wires to be as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.
- F. Polyvinyl Chloride (PVC) Coated Conduit: Provide PVC-coated rigid steel conduit and fittings where required for highly corrosive atmospheres.
- G. Flexible Conduit: Provide flexible conduit, minimum 18" for connection of lighting fixtures and other electrical equipment connections, where subject to movement and vibration.
- H. Liquid-tight Conduit: Provide liquid-tight flexible conduit, minimum 18" for connection of all motors, and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:
 - 1. Exterior location
 - 2. Moist or humid atmosphere where condensate can be expected to accumulate
 - 3. Corrosive atmosphere
 - 4. Subjected to water spray
 - 5. Subjected to dripping oil, grease, or water.

- I. Conduit Location: All horizontal runs of conduit (not strapped to walls) shall be above 8 feet high, with a vertical drop to equipment. Conduit blocking walk and service space will not be acceptable and will require relocation. Conduit on and adjacent to equipment shall be located to allow free access to all removable panels for equipment service.
- J. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable conduit, and make motor connections. All conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet.
- K. Coordination: Coordinate installation of electrical connections for equipment with equipment installation work.
- L. Identification: Refer to Section 16010 for identification of electrical power supply conductor terminations with markers approved as to type, color, letter, and marker size by the Contracting Officer. Affix markers at each point of termination, as close as possible to each point of connection.

END OF SECTION

SECTION 16915

MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of miscellaneous electrical controls and control wiring work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
- B. Types: The types of miscellaneous electrical controls and control wiring specified in this Section include, but are not necessarily limited to, the following:
1. Miscellaneous Electrical Controls:
 - a. Contactors
 - b. Relays
 - c. Photocells
 - d. Time switches.
 2. Miscellaneous Control Wiring:
 - a. HVAC equipment
 - b. Stop-start stations and all necessary inter-connecting and interlock wiring for all motors, controllers, interlocks, safety devices, and similar items.
 - c. Additional control wiring and safety devices as shown and specified.

1.3 QUALITY ASSURANCE:

Manufacturers: Provide products produced by one of the following:

- A. Contactors and Relays:

1. Automatic Switch Company
 2. Russelectric, Inc.
 3. Square D Company.
- B. Photocells and Time Switches:
1. AMF Paragon
 2. Intermatic Time Controls
 3. Precision Multiple Controls, Inc.
 4. Tork, Inc.

PART 2 - PRODUCTS

2.1 CONTACTORS AND RELAYS:

- A. General: Provide contactors and relays as shown and specified herein. The number of poles, ampere-ratings, and pole arrangements shall be as shown. All contactors and relays shall conform to the following:
1. Be rated for continuous duty at full rated current in an unventilated enclosure. Eight-hour duty ratings will not be acceptable.
 2. Contacts shall be readily replaceable, self-aligning, silver or silver tungsten alloy.
 3. Control voltage shall be 120 volt, 60 Hertz, unless otherwise specified.
 4. All auxiliary contacts shall be rated for not less than 10 amperes.
 5. Contactors rated for lighting and mixed loads shall have an interrupting capacity of 150 percent of their continuous duty rating.
 6. Be capable of successfully handling inrush currents at 20 times rating.
- B. Mechanically-held Devices: Mechanically held devices shall conform to the following:
1. Be single solenoid operated.

2. Be positive locking without the use of latches, hooks, or magnets.
 3. Control stations shall be momentary action, unless otherwise shown, and make-but-not break coil current.
 4. Permit manual operation in either direction and provide a visual indication of contact position.
 5. Control circuits shall be 3 wire with separate open and close circuits, unless otherwise shown.
 6. Contactors rated at 225 amperes or less shall operate satisfactorily in any mounting position.
- C. Magnetically-held Devices: Magnetically held devices shall conform to the following:
1. AC operated units shall have laminated low loss electrical steel core pieces with machine ground pole faces and shading coils.
 2. Units rated at 300 amperes and above shall have DC operating coils and include the necessary rectifier for the AC/DC operation.
 3. Normally open contactors shall be spring-loaded open and magnetically closed.

2.2 INTERIOR AND EXTERIOR LIGHTING CONTROL:

- A. Photocells: Tork 2101, SPST, 2000 watt, 120 volt.
- B. Time Switches: Tork 7200ZL, DPST, reserve power, 40 amp contacts, astronomic dial, NEMA 1 surface mounted enclosure.

2.3 WIRING AND RACEWAYS:

- A. Line Voltage Control Wiring: This wiring shall be as specified in Section 16120.
- B. Low Voltage Control Wiring: This wiring shall be as specified in Section 16120, except that conductors shall consist of a multi-conductor jacketed cable whenever possible.
- C. Raceways: Raceways for line voltage and low voltage control wiring shall be as

specified in Sections 16110 and 16130.

PART 3 - EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS ELECTRICAL CONTROLS:

- A. General: Install miscellaneous electrical control devices as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Conductors: Connect electrical conductors to miscellaneous electrical control devices in accordance with equipment Manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.
- C. Contactors and Relays: Install contactors and relays mounted in panel boards or individual enclosures as shown and be complete, including all control wiring and devices.
- D. Photocells and Time Switches: Install lighting controls as shown. Photocell and time switch settings shall be as directed by the Contracting Officer.
- E. Line and Low Voltage Control Wiring: Line and low voltage control wiring shall be installed in a suitable raceway.
- F. Connections: Refer to Section 16910 for connections to equipment.

END OF SECTION

SECTION 16920

HVAC CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 govern this Section.

1.2 DESCRIPTION OF WORK:

- A. Work Included: The extent of HVAC control wiring is as specified in Section 15970 as indicated on the Drawings, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All low voltage (below 50 volts) shall be by Division 15, Mechanical, but shall be furnished and installed in accordance with this Section 16920.
- B. Type: The type of HVAC control wiring specified in this Section includes, but is not necessarily limited to:
 - 1. Line voltage (120-volt) control wiring
 - 2. Low voltage (24-volt) control wiring
- C. Work of other Sections: The following Section applies to the Work of this Division or Section: Section 15970, "Control Systems"

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. Line Voltage Control Wiring: Line voltage wiring shall be as specified in Section 16120. Line voltage control wiring not indicated on the Electrical Drawings shall be the responsibility of Division 15, Mechanical.
- B. Low Voltage Control Wiring: Low voltage control wiring shall be as specified in Section 16120, and shall be furnished and installed by Division 16, Electrical.

- C. Raceways: Raceways for control wiring shall be as specified in Section 16120 and Section 16130 and shall be furnished and installed by Division 16, Electrical.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC CONTROL WIRING:

- A. General: Install temperature control wiring in accordance with approved shop drawings, applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.
- B. Line and Low Voltage Control Wiring: Line and low voltage control wiring shall be installed in a suitable raceway.
- C. Number-Code or Color-Code: Code conductors appropriately for future identification and servicing of the system.
- D. Coordination: Coordinate temperature control wiring and installation with Division 15 requirements. All applicable submittals by this Division shall certify that such coordination has been performed.

END OF SECTION