

SECTION 16010 GENERAL PROVISIONS

PART 1 - GENERAL

Related Documents:

Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.1 GENERAL REQUIREMENTS:

- A. This Division is an integrated whole comprising interrelated and interdependent Sections and shall be considered in its entirety in determining requirements. Refer to other sections of this Division for additional requirements or information regarding the topics of this Section.

1.2 SUBMITTALS:

- A. Material Lists and Manufacturers Literature.
- B. Annotated Division 16 Specifications.
- C. Shop Drawings.
- D. Electrical Room/Closet Layout Plans.

1.3 DEFINITIONS (as used on Division 16 drawings and herein):

- A. "Provide" means furnish, install and connect unless otherwise described in specific instances.
- B. "Extend", "Submit", "Repair" and similar words mean that the Contractor shall accomplish the action described.
- C. "Codes" or "Code" means all codes, laws, statutes, rules, regulations, ordinances, orders, decrees, and other requirements of all legally constituted authorities having jurisdiction.
- D. "Verify Location" when noted for an item, such as a receptacle, outlet, light fixture, stubouts/stubup/stubdowns, etc., means that the location of the item within the room is tentative and not necessarily as shown on the drawings. Contractor shall request the exact location of the item from the Owner's representative during construction. The item may be located anywhere in the room by the Owner's representative at no additional cost to the Owner.
- E. "Products", "materials" and "equipment" are used interchangeably and mean materials, fixtures, equipment, accessories, etc.
- F. "Utility areas" are defined as mechanical, electrical, telephone, janitorial and similar rooms or spaces which are normally used or occupied only by custodial or maintenance personnel. "Public areas" are defined as the rooms or spaces which are not included in the utility areas definition.

1.4 DESCRIPTION:

- A. Provide a complete and operable installation, including all labor, supervision, materials, equipment, tools, apparatus, transportation, warehousing, rigging, scaffolding and other equipment and services necessary to accomplish the work in accordance with the intent and meaning of these contract documents.

1.5 INTERRELATED WORK:

- A. Contractor shall coordinate the installation layout of the [HVAC-] [plumbing-] [fire sprinkler-] [food service-] [surveillance-] [signage-] [water feature-] electrical systems to ensure that the work will be installed in the available space without modification to the architectural and structural work. Where space for these systems is limited or restricted, the system installers shall jointly prepare [HVAC] [plumbing-] [fire sprinkler-] [food service-] [surveillance-] [signage-] [water feature-] electrical coordination layout drawings at appropriate scale and degree of detail.
- B. Examine the drawings and specifications of all other Divisions of this specification for work related to the work of this Division. Order the work of this Division so that progress will harmonize with that of other Divisions and all work will proceed expeditiously.

1.6 EXISTING CONDITIONS:

- A. Visit the site prior to bidding and investigate the existing conditions which affect or will be affected by work of this Division. Become thoroughly familiar with the working conditions and take into account any special or unusual features peculiar to this job. By the act of submitting a Bid, the Contractor will be deemed to have complied with the foregoing, to have accepted such conditions, and to have made allowance therefore in preparing his Bid.
- B. The location of existing concealed utility lines are shown in accordance with reference data which must be considered to be unreliable. The Bidder shall include adequate funds in his Bid to cover costs of connection regardless of their exact location. There may be existing utility lines in addition to these indicated.

1.7 DRAWINGS AND SPECIFICATIONS:

- A. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification.
- B. The Owner's representative shall interpret the drawings and the specifications, and his decision as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.
- C. In case of conflicts not clarified prior to Bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award and if appropriate a deductive change order will be issued.
- D. All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".

1.8 CHANGE ORDERS:

- A. Contractor shall clearly understand that the electrical work shown on the drawings and described in these specifications is subject to revision. Furnish backup data segregated by each electrical drawing involved in the Change Order and further broken down into credits (deletions) and costs (additions) per drawing. This is required to facilitate review by the Owner's representative.

1.9 ELECTRIC POWER, TELEPHONE AND CABLE TV SERVICES:

- A. Contractor shall be responsible for and shall include in his work all equipment, material and labor required to provide power, telephone and cable TV service and to extend, remove or rearrange existing utilities as shown on drawings for this project. All service charges levied by all utility companies [shall] [shall not] be a part of this contract.
- B. Within 5 days after award of contract, notify the serving utilities that the project is under construction and apply for permanent service in the name of the Owner. Furnish pertinent information to them including the required dates for permanent service. Verify service locations and conform to utility company requirements. [Contractor shall pay charges for permanent service connections levied by the utilities] [for which he will be reimbursed by the Owner. Refer to Section 00300 - "Supplementary Conditions" for requirements pertaining to connection fees and capacity changes. The reimbursement shall be limited to the actual amount of the utility service charges and a copy of the billing from the utility company shall accompany the Contractor's invoice.]
- C. Work shall conform to the requirements of the following utilities:

Electrical: San Diego Gas & Electric
Planner:
Phone:

Telephone: Pacific Bell
Planner:
Phone:

Cable TV: Cox Communications
Planner:
Phone:

- D. All service conduits, equipment, and locations shall be approved by the utilities before installation. Utilities may require work at variance with the contract documents.

1.10 SEQUENCING (PHASING) OF CONSTRUCTION:

- A. Contractor shall consult with the General Contractor regarding this topic and shall make allowance therefore in preparing his bid.

1.11 DEMOLITION:

- A. Contractor shall consult with the General Contractor regarding this topic.
- B. Hazardous or environmentally sensitive materials such as lamps, ballasts, etc. shall be disposed of in accordance with Federal, State and local regulations.

1.12 PERMITS AND INSPECTIONS:

- A. Obtain, schedule and pay for permits, licenses, approvals, tests, and inspections required by legally constituted authorities having jurisdiction over the work.
- B. Permit and inspection requirements shall be as specified in Section 00100 "Instructions to Bidders" section.

1.13 OBSERVATION OF CONSTRUCTION:

- A. Afford the Owner's representative every facility for evaluating the skill and competence of the mechanics and to examine the products. Concealed work shall be reopened when so directed during his periodic visits.

1.14 CODES AND REGULATIONS:

- A. By submitting a Bid, Contractor is deemed to represent himself as competent to accomplish the work of this Division in conformance with applicable Codes. In case of conflict between the Contract Documents and Code requirements, the Codes shall take precedence. Should such conflicts appear, cease work on the parts of the contract affected and immediately notify the Owner's representative in writing. It shall be the Contractor's responsibility to correct, at no cost to the Owner, any work he executes in violation of Code requirements. Specific references to Codes elsewhere in this Division are either to aid the Contractor in locating applicable information or to deny him permission to use options which are permitted by Codes.
- B. Applicable Codes: (Current editions unless otherwise noted):
 - a. National Fire Protection Association (NFPA) Standards
 - b. National Electrical Code
 - c. Uniform Building Code
 - d. Fire Marshal Regulations
 - e. Reservation [State of California Public Utilities Commission General Orders #95 and #128 (G095 and G0128).]
 - f. Regulations of all other applicable codes and authorities having jurisdiction.
- C. Where conflict or variation exists among Codes, the most stringent shall govern.

1.15 RECORDS AND DOCUMENTATION:

- A. Accumulate the following and deliver to the Owner's representative prior to final acceptance of the work.
 - a. Record Drawings:
 - 1. Maintain in good order in the field office a complete set of "as-built" electrical prints. Update the drawings daily with neat and legible annotations in red ink showing the work as actually installed.
 - 2. The actual size, location and elevation of all buried lines, boxes, monuments, and stubouts shall be accurately located and dimensioned from building walls or other permanent landmarks.
 - 3. Furnish the originals.
 - b. O&M Manuals: Furnish 3 copies of an operating and maintenance manual. Each manual shall be bound and indexed and shall include the following:

1. Operating and service instructions for systems and equipment as required by other sections of this Division. A spare parts list recommended for purchase by Owner shall be included.
 2. Updated approved materials list, shop drawings, and catalog information as required by Submittals subsections.
 3. List of material and equipment manufacturers (with names, addresses and phone numbers of local suppliers) in order to expedite ordering of replacement parts by the Owner. This list may be integrated with the material list.
- c. Permits and Certificates of Inspection: Furnish the originals.
 - d. Testing procedures and test results required in this and other sections: Furnish 2 copies.
 - e. Other data required by other sections of this Division: Furnish 2 copies.

1.16 TOOLS:

- A. Provide all special tools needed for proper operation and routine adjustment and maintenance of systems and equipment. Deliver tools to Owner's representative and request a receipt for same.

1.17 GUARANTEE:

- A. All work shall be guaranteed in conformance with [General Conditions of Contract] and [Division 1] for a minimum period of one year from either the official date of completion or from the official notice of acceptance, whichever is the later date.
- B. The guarantee period for certain items shall be longer, as indicated in the specification for those items. [Longer guarantee periods are specified [in the following Sections and paragraphs:] [for the following:]]

- (List Applicable Sections or Materials) -

- C. Should any trouble or fault develop during the guarantee period due to defective material, faulty workmanship, or non-compliance with plans, specifications, codes or directions of the Owner, Architect, Engineer, or Inspector, the Contractor shall furnish all necessary labor and materials to correct the trouble without additional charges.
- D. The guarantee period shall be extended by any period of time the guaranteed item is defective or out of service due to trouble or fault.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Materials shall be new, in accordance with the specifications of the Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), National Fire Protection Association (NFPA), and the National Electrical Code (NEC), and shall have an Underwriter's Laboratories (UL) listing and bear their label where such services are available.
- B. Where applicable, listing or labeling shall apply to the complete assembled equipment and not to the components alone. Where listing or labeling service is not available for an assembly, the components shall be listed or labeled and applied within their tested rating.
- C. Materials for the same purpose shall be of the same make and shall be the manufacturer's latest standard design that complies with the specification requirements.

2.2 SUBSTITUTIONS:

- A. [Substitutions will be allowed only in strict conformance with the Conditions of the Contract and Division 1.]
- B. Class 1 Products: Whenever on the drawings or in these specifications, products are identified by the name of one or two manufacturers followed by the words "(no substitution permitted)" or by the name and catalog number of one or two manufacturers followed by the words "(no substitution permitted)", it is intended that the specified products of these manufacturers shall be furnished.
- C. Class 2 Products: Whenever on the drawings or in these specifications, products are identified by the name of one or two manufacturers or by the name and catalog number of one or two manufacturers, it is intended that products by other manufacturers, which in the opinion of the Owner's representative are equivalent to the specified product, may be furnished.
- D. Class 3 Products: Whenever on the drawings or in these specifications, products are identified by the name or name and catalog number of one manufacturer and two or more additional manufacturers are listed as "Acceptable Manufacturers", it is intended that products by "Acceptable Manufacturers", which in the opinion of the Owner's representative are equivalent to the specified product specified by catalog number, may be furnished.
- E. Class 4 Products: Whenever on the drawings or in these specifications, products are identified by the names and catalog numbers of three or more manufacturers it is intended that the specified products of those manufacturers shall be furnished.
- F. Substitutions for Class 3 and Class 4 Products: If a Contractor wishes to propose products by manufacturers other than those specified, the following procedures shall be followed.
 - a. Prior to Award of Contract: Product substitution proposals may be submitted with the Bid as Alternates to the Basic Bid and shall include the credit or additional cost. The proposal shall be accompanied by samples or sufficient data about the products to permit a proper evaluation. These alternates may be given consideration in awarding the Contract; however, no obligation to do so is implied.

- b. After Award of Contract: Request permission from the Owner's representative to submit product substitutions for consideration. The request shall include the reason for the request, a brief description of the substitutions, and the credit or additional cost for each. If the request to submit is granted, the products shall be submitted for evaluation of equivalency in the usual manner.
- G. Equivalency: The proposal to supply products other than those specified shall be accompanied by sufficient data about the products to permit a proper evaluation, including ratings, dimensions, and all significant differences. Submit with Material List a complete breakdown of the requested substitutions. Factors which will be considered in the Owner's representative's determination of equivalence include quality, performance, utility, and appearance. The Owner's representative's decisions about equivalency shall be final.
- H. By proposing a substitution, it is deemed that the Contractor will bear the cost of all changes (including architectural, structural, electrical and mechanical changes) necessary to accommodate the substitution. If redesign of Contract Documents is necessary, such re-design costs shall also be included.
- I. Specific: Refer to other sections of this Division for additional requirements.

2.3 SUBMITTALS:

A. General:

- a. Owner's representative review of the submittal is only for general conformance with design concept of the project and general compliance with the information given in the contract documents. The submittal procedure is required in an effort to minimize the problems which occur due to the discovery of Contractor non compliance at the construction site. The Contractor is responsible for confirmation and correlation of the dimensions, quantities and sizes, for information that pertains to fabrication methods or construction techniques, and for coordination of work of all Divisions of the work. Deviations, if any, from Contract Documents shall be clearly and completely indicated (by a separate letter if deviations are extensive) in the submittals, and the lack of such is deemed complete compliance with Contract Documents without any deviations. Submittals favorably processed will not relieve the Contractor of responsibility for deviations not so reported nor for errors in the submittal.
- b. Contractor Stamp: All submittals shall be stamped with the following text and signed by the Contractors representative.

"IT IS HEREBY CERTIFIED THAT THE PRODUCTS SHOWN AND MARKED IN THIS SUBMITTAL ARE IN COMPLIANCE WITH THE CONTRACT DOCUMENTS AND CAN BE INSTALLED IN THE ALLOCATED SPACES EXCEPT WHERE DEVIATIONS ARE NOTED.
CERTIFIED BY: _____ DATE: _____"

- c. All submittals shall be complete and with catalog data and information properly marked to show, among other things, equivalency of product (where substitution is requested), adequacy in capacity and performance to meet minimum capacities or performance as specified or indicated. Arrange the submittals in the same sequence as these specifications, and reference (at the upper right-hand corner) the particular specification provision for which each submittal is intended. Incomplete submittals will be rejected.

- d. Late, incorrect, improper or rejected submittals will not be acceptable reasons for delaying the work or substituting non-specified material or equipment. The Contractor is responsible for providing proper submittals and allowing adequate time for their processing.
 - e. Refer to the other sections of this Division for specific requirements.
- B. Annotated Division 16 specifications: Concurrent with the submittal of Material List and Manufacturer's Literature, submit copies of the Division 16 specifications (including addenda) which have been annotated, underlined, highlighted, or otherwise marked up by the Contractor, to indicated contract requirements which are different from Contractor's standard practice. At least one copy shall be placed in the Contractor's field office for ready reference by construction personnel and a second copy in the Contractor's central facility for use by material ordering personnel. This procedure is required in an effort to minimize the problems which occur due to the discovery of Contractor non compliance at the construction site.
- C. Material List: Submit for approval a complete list of materials proposed for use. Furnish names and addresses of manufacturers, catalog numbers (where applicable) types and trade names. For purposes of uniformity, only one manufacturer will be accepted for each class or type of material. This list is in addition to Shop Drawings.
- D. Equipment Shop Drawings: Shop drawings and data sheets for devices, fixtures, equipment and systems shall be submitted as required in the specifications for those items. Include information on each component, wiring diagrams, layouts, finish, dimensions, and sufficient other data to establish compliance with the specifications and acceptability of the device, equipment, or system. Do not authorize fabrication of the equipment until approved drawings are received.
- E. Branch Circuit Wiring Shop Drawings: The contractor shall submit six (6) sets of power and lighting shop drawings indicating all proposed routing of the branch circuit conduit and wiring. Drawings shall be drawn at same scale as noted on contract drawings. Branch circuiting for power systems shall be on separate sheets from lighting systems. However, a common site plan may be utilized to show a combination of both power and lighting branch circuitry. Contractor shall utilize symbology shown on contract documents and in all cases indicate location of homeruns and number of conductors in each length of conduit between outlets, fixtures and equipment.

Shop drawings shall be neatly drafted. Rough sketches or incomplete representations will not be accepted. CAD files [will] [will not] be available to the Contractor for preparation of these shop drawings.

Refer to contract drawings for panel and respective circuit breakers corresponding with each outlet, fixture, or piece of equipment. Designed circuit numbers shall be used as indicated.

The contractor shall be responsible to coordinate branch circuit conduit routing with the structure and all other trades.

All branch circuit wiring and conduit shall be sized per National Electric Code, unless otherwise noted on the drawings. No more than six current carrying conductors shall be allowed in a single conduit unless additional derating factors are applied per NEC. Increase wire sizes accordingly to compensate for deration factors per Article 310.

Contractor must obtain approval on submitted shop drawings prior to commencing rough-in electrical work. Any deviations proposed by the contractor on branch circuit routing after receipt of approved shop drawings shall first be approved in writing by the Architect. Changes shall be shown on the final "As-Built" plans by the Contractor.

- F. Electrical Room/Closet Layouts: Furnish a scale drawing of all electrical rooms and closets where power distribution equipment is provided. Indicate location and size of equipment to be provided, and the routing of feeder conduits within the space. Do not begin installation until the Owner's representative has approved the layouts.
- G. Samples: Samples of any item may be required, whether listed here or not, at the discretion of the Owners representative. The owner's representative or the owner shall not be charged for the sample. All costs including freight or postage shall be at the Contractor's expense. Samples shall be returned to the Contractor when review has been completed.
- H. Other Submittals: As required by other sections of this Division.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION METHODS:

- A. Workmanship shall be in conformance with the "NECA (National Electrical Contractors Association) Standards of Installation" and the best standard practice of the trade except where specifically indicated otherwise.
- B. Execute the work so as to contribute to ease of operation and maintenance, maximum accessibility and best appearance. Execute it so that the installation will conform and adjust itself to the building structure, its equipment and its usage. The work shall be symmetrical, plumb, uniform, properly aligned and firmly secured in place.
- C. Install equipment in accordance with the manufacturer's instructions and recommendations unless otherwise noted or specified.

3.2 SCHEDULING OF WORK AND INTERRUPTIONS TO ELECTRICAL SYSTEMS:

- A. All existing electrical systems such as telephone/data/LAN, fire alarm, surveillance, access control, background music, UPS power, electric power and similar systems shall be maintained in operation at all times unless an interruption is necessary to the prosecution of the work.
- B. Interruption of electrical systems shall be scheduled by request to the Owner's representative at least 15 days in advance of the proposed date. The day of the outage shall be any day of the week (including Saturday or Sunday), and anytime of the day or night selected by the Owner's representative. Prior to the outage, all possible work shall have been completed which will minimize the length of the required outage. During the outage, all feasible portions of the system requiring an outage shall be worked on simultaneously, and the work shall be prosecuted with diligence by an adequate number of skilled personnel.

3.3 COORDINATION WITH STRUCTURAL REQUIREMENTS:

- A. The placement of conduits, etc., and the location, size and reinforcement of holes in the building structure shall conform to the structural drawings and specifications. When the requirements of the Electrical Division of the specifications or drawings are in conflict with the structural requirements, the structural requirements shall take precedence. Where the safety of the building structure is threatened, due to electrical work or holes required for such work, modifications shall be made as directed by the Owner's representative.

3.4 LOCATIONS, SIZES, ROUTINGS AND CLEARANCES:

- A. For the purpose of clearness and legibility, the drawings are essentially diagrammatic. The size and location of equipment is shown to scale wherever possible, but the Contractor shall make use of all the data in the Contract Documents, and shall verify such information. Contractor is responsible for the equipment provided by him fitting in the spaces available while maintaining required working, ventilation, and equipment maintenance access space. Exercise particular care that such space is not infringed by the work of other Divisions.
- B. Conduit Routing: The drawings show the points of termination of the conduits, and may suggest a route for the conduit. However, it shall be the responsibility of the Contractor to install the conduits with a minimum number of bends in such a manner as to conform to the structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and meet all Code requirements with such offsets and special fittings as may be required.
- C. Existing Conditions: The exact locations of borings, trenches, excavations, manholes, pullboxes, ground rods and all new sub-surface work shall be adjusted to avoid damaging or disturbing any existing-to-remain underground structure, pipe, or cable. The Contractor shall make every reasonable effort to determine their existing correct locations, including: obtaining record drawings that show location of existing utilities and having existing utilities located and marked for both routing and depth prior to commencing trenching operations.
- D. Mounting Heights: Mounting heights shown are from finished floor, pavement or grade to middle of wall mounted outlet boxes, and from finished floor to lowest point of suspended fixtures or devices, unless otherwise indicated.

3.5 TESTS:

- A. General:
 - a. Demonstrate that all components of the work of this Division have been provided and that they operate in accordance with the Contract Documents.
 - b. Provide instruments and personnel for tests and demonstrations. Submit signed test results.
 - c. Notify the Owner's representative in writing, seven (7) days in advance of tests to allow presence of Owner's representative.
- B. Specific: Refer to the other sections of this Division for test requirements.

3.6 DELIVERY, HANDLING, STORAGE OF MATERIALS AND PROTECTION OF WORK:

- A. Protect materials against dirt, water, chemical and mechanical damage both while in storage and during construction.
- B. Cover materials in such a manner that no finished surfaces will be damaged, marred or splattered with plaster or paint, and all moving parts will be kept clean and dry.
- C. Replace or refinish all damaged materials including fronts of panels and switchboard sections as directed by Owner's representative.
- D. Keep raceways, boxes, cabinets, and other openings closed to prevent entry of foreign matter.

3.7 TEMPORARY LIGHTING AND POWER:

- A. Contractor shall provide on-site generation, labor, materials and/or any required utility fees associated with the installation and maintenance of a temporary power sources for Contractor's equipment or field offices during the period of construction.
- B. Building and site shall be sufficiently illuminated so that construction work can be safely performed. Lights shall be controlled by switches located with consideration for safety, security, and convenience.

3.8 CLEANUP AND HOUSEKEEPING:

- A. Cleaning shall be done as the work proceeds. Remove waste and debris to keep the site as clean as is practical.
- B. Vacuum clean dirt and debris from interiors of switchboards, panelboards, transformers, and similar items. Leave exposed parts of the electrical work in a neat, clean and usable condition (including the tops of equipment which are higher than normal eye level), with painted surfaces unblemished and plated metal surfaces polished. Clean lighting fixtures and wipe lamps clean.
- C. Clean and vacuum floors, ceilings and walls, and wet mop the floors of electrical rooms and closets.

3.9 JOB VISITS:

- A. Periodic visits to the project construction site by the Owner's representative are for the purpose of observing the progress of construction and generally verifying that work is proceeding in accordance with the intent of the Construction Documents.
- B. Such visits shall not be construed to be construction supervision nor the assumption of responsibility for construction means, methods, sequences, and safety by the Owner=s representative.
- C. The Contractor shall be present during scheduled job visits and shall, upon request open boxes, panels, switchboards, or other equipment and shall operate equipment, apparatus, or systems to demonstrate compliance with contract documents.

- D. Observation reports will be forwarded to the Contractor for prompt correction of unsatisfactory work and completion of incomplete work. Failure to note improper or incomplete work in an observation report does not relieve the Contractor of the responsibility for complete and correct work conforming to the contract documents.

3.10 WORK IN HAZARDOUS (CLASSIFIED) LOCATIONS:

- A. In areas classified on the plan or by the authorities having jurisdiction as hazardous, all equipment, wiring, and work shall meet all applicable code and listing requirements for the class, division, and group of hazard.
- B. Wiring for all classifications shall be run in rigid metal conduit except where intrinsically safe or other wiring methods are specifically shown or required. Fittings and connections shall be made up wrench tight.

3.11 ACOUSTICAL CONTROL WORK:

- A. Certain rooms are designated "NOISE CRITICAL" on the Architectural plans and include the trap room, stage, house, chiller room, dimmer room, elevator machine room, sound booth, control booth and upper level fan room. Every precaution shall be taken to maintain airtight construction in these areas to prevent the transmission of sound. Conduit penetration, light fixtures, boxes, cabinets and other electrical material shall be installed with openings around them grouted, gasketed, packed, caulked, taped or filled to prevent sound transmission.
- B. Fixture ballasts shall have a class "A" sound rating throughout. Contractor will be required to replace any noisy ballasts at his expense.
- C. All electrical conduit connected to vibrating equipment or transformers shall be flexible type at least 3 feet or 20 diameters, whichever is longer, installed very slack in such a manner as to prevent sound or vibration transmission from the equipment.
- D. Electrical equipment producing sound, such as ballasts, rectifiers, contactors, and transformers, shall not be installed on framed walls common with the house area.
- E. Contractor shall take any further measures necessary to prevent sound being caused or transmitted by or through electrical equipment and material.

END OF SECTION

SECTION 16200
POWER DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS:

- A. Material List and Manufacturers Literature.
- B. Shop Drawings.
- C. O & M Manuals

1.2 ACCEPTABLE MANUFACTURERS:

- A. Switchboards, breakers, service/metering equipment, motor control centers, panelboards, loadcenters, transformers, safety switches and ground fault protection. General Electric, Siemens, Square D, Westinghouse, [or equal]
- B. Bolted Pressure Switches Pringle, [or equal].
- C. Fuses Bussmann, Littell Fuse, Gould/Shawmut, [or equal].
- D. Motor Starters Allen Bradley, Furnas, General Electric, Square D, Westinghouse, [or equal].
- E. Lighting Contactors General Electric, Square D, Asco, [or equal].
- F. All power distribution equipment shall be by the same manufacturer.

1.3 SHORT CIRCUIT (FAULT CURRENT DUTY) AND SELECTIVITY REQUIREMENTS:

- A. The available short circuit current values indicated for the distribution system may be accommodated in the following several ways. If the available short circuit current is not indicated for a specific distribution system component, use the nearest upstream value indicated. Bus bar bracing shall be adequate for the values indicated.
 - a. Adequate interrupting ratings for all circuit breakers in the equipment.
 - b. Use of a current limiting breaker with an adequate interrupting capacity and current limiting suitable for use with the downstream breakers proposed.
 - c. UL integrated short circuit ratings for the assembly or for the series combination of circuit breakers.

PART 2 - PRODUCTS

2.1 DRY-TYPE TRANSFORMERS - UNDER 600 VOLTS PRIMARY:

- A. Transformers shall be ventilated dry type Class H, [80] [115] [150]EC. rise, self-cooled with KVA ratings as shown on the drawings. [Transformers shall have harmonic content (AK@-rating) [as indicated] [of K=13]] Single phase and three phase transformers 10 KVA and below shall have two 5% full capacity taps below normal. Transformers above 10 KVA shall have two 2-1/2% full capacity primary taps above normal and two 2-1/2% full capacity primary taps below normal. Taps will be changed only when transformer is de-energized. The transformer core shall be cold-rolled, grain oriented silicon steel. Basic impulse level shall conform to ANSI Standard C57.12. Sound level shall [not exceed] [be 3 dB below] ANSI and NEMA Standards. Impedance shall be [approximately 4% for under 500 KVA and approximately 5.75% for 500 KVA and over.] [manufacturer's standard.]
- B. The enclosure shall be fabricated from 14 gauge or thicker steel. For floor mounting type, the base shall be 11 gauge or heavier and suitable for rolling or skidding into position. The terminal compartment shall be at the bottom. Accessories for installation such as lifting rings, jacking plates and wall mounting tabs shall be provided as required. Construction shall be drip proof and rodent proof. Where mounted outdoors exposed to the weather, transformers shall have raintight enclosures. Finish shall be baked on enamel.
- C. Transformers shall have front, bottom and/or side cooling [only, with no provisions for back cooling, so that the transformers can be installed against the wall]. [Provide a protective hood on top.] [Transformers shall be mounted on rubber isolation pads [and connected with flexible conduits] for sound attenuation. The Contractor shall ascertain that the transformers he proposes to use will fit in the space allowed.
- D. A metal nameplate shall be installed by the manufacturer prominently on the outside of the enclosure. Nameplate shall have as a minimum the following information: Manufacturer, KVA, voltages, serial number, catalog number, type, impedance and wiring data.
- E. Transformers for buck-boost use shall be dry type, insulating, epoxy encapsulated, non-ventilated, and shall be designed for connection as an auto-transformer and for buck-boost application.

2.2 SWITCHBOARDS - UNDER 600 VOLTS:

- A. All new switchboards shall be by the same manufacturer.
- B. Sections shall be shipped connected together by the manufacturer, or separated and ready for field connection by the Contractor, in sizes that will allow them to be moved through the doors into their positions in the building.
- C. Sections shall be [free standing,] [or wall mounted,] with front [and rear] access, as shown or required, of angle iron or formed steel framework with steel panels enclosing all except the bottom. No raw or sharp metal edges shall be visible. Sections shall be constructed to UL standards.

- D. Finish shall be [manufacturer's standard cataloged] [ANSI 61 enamel over primer] for [indoor] or [outdoor] use, as shown on the drawings. [Finish for outdoor switchboards shall] [be Munsell] [Outdoor Green #7.0GY3.25/1.5] [Light Gray #5.0GB7.0/0.4] [match transformers and other exterior switchgear.] [field painted over factory finish to match surrounding surfaces.]. Finish [other than field painting] shall be applied by the manufacturer.
- E. Bussing shall be [copper] or [electrical grade aluminum], and shall be formed and braced to withstand the effects of a fault current of minimum [50,000] [30,000] amperes symmetrical. Copper bussing shall be silver plated at joints, and be connected with bolts and lock washers torqued [to ANSI standards] [as recommended by the manufacturer.] [Aluminum bussing shall be tin plated full length.] All joints shall be made by welding or use of bolts and Bellville washers made up tight. Main bussing shall extend through all sections of the switchboard, and shall be of a current carrying capacity equal to the current rating of the main protective device as shown on the drawings. Neutral bussing shall be rated [100%] [200%] of phase bussing. Busses shall be spaced according to the UL and NEC standards for bare busbar. Provide top and bottom provisions for future crossbus and cable extension. The vertical bus shall be drilled and tapped to accommodate new and future breakers, switches and devices. Cross busses near the bottom of the boards shall be insulated or barriered.
- F. A continuous copper ground bus shall be provided through all sections of the switchboard. All non-current carrying parts of the switchboard shall be solidly connected to this ground bus. The ground bus shall be sized to an ampacity of not less than 33% of the rating of the respective main bus.
- G. With a 70EF temperature in the room where installed, the phase, neutral, and ground bus shall be sized and rated for 100% continuous current carrying capacity based upon an ampere per square inch formula. Bus current carrying capacity ratings and physical sizing shall not be based on temperature rise alone. [Copper bus shall have a minimum conductivity of 1000A/Square Inch;] [aluminum bus shall be a minimum conductivity of 800A/ Square Inch at full operating capacity.] The temperature in any interior part of the switchboard shall not exceed 115EF.
- H. All lugs for cable connections shall be positive pressure bolted clamp type.
- I. Exterior plates and blank spaces not presently utilized shall be held in place by rigid supports arranged to prevent screws and plates from falling against energized parts. Interiors shall be fastened to the enclosure by adjustable supports to provide for proper alignment.
- J. Provide meter sockets and switches for future services where shown and provide bussing and blank faceplates at spare sections suitable for future installation of feeder circuit breakers or switches.
- K. Underground service pull section shall be top bussed and shall comply with the requirements of the serving utility.
- L. [Securely anchor switchboards to the housekeeping pad, floor, or wall to conform to [seismic standards specified under Section 16300 - "SEISMIC RESTRAINTS" [details shown on the drawings.] [details provided by the equipment manufacturer.]

- M. [Securely anchor switchboard to a channel iron base which shall be furnished complete by the switchboard manufacturer. Bases shall be drilled and tapped to receive the switchboard and shall be fastened securely to the floor or pad. Fill the entire base with grout and finish smooth. [[Switchboards shall be secured in accordance with the [Section 16300 - "SEISMIC RESTRAINTS.] [details shown on the drawings.] [details provided by the equipment manufacturer.]]]
- N. [Switchboards located outside shall have weatherproof enclosures and finish, and padlockable doors.] Switchboards installed outdoors or exposed to weather shall have hinged front doors with vault type padlockable handles and three point latches. All openings shall be suitably designed to prevent the entry of weather, dust, animals and foreign matter. A lighting fixture, switch and duplex convenience outlet shall be factory installed and connected inside each weatherproof cubicle containing switching devices. [or instruments.] Light shall be located to illuminate nameplates and operating handles.
- O. Provide a nameplate for each switchboard section and each item on the face of the switchboard as specified in the Section 16300 - "IDENTIFICATION SYSTEMS". Switchboard submittal shall contain a nameplate schedule.
- P. After installation, the boards shall be carefully cleaned. Any damaged paint shall be retouched with matching paint provided by the manufacturer of the switchboards.
- Q. When the equipment is energized, live parts shall be protected by faceplates which shall not be removed or left unplaced without the immediate presence of the Electrical Contractor.
- R. Switchboards arranged as motor control centers shall be NEMA Class 1 [] Type B [] construction and shall have combination plug-on or bolt-on units containing breakers, fuses, starters, contractors and all components shown on the drawings or required. Refer to Electrical, Mechanical, Plumbing, and Control Drawings and Specifications for material and work to be included as a part of control center units.
- S. Circuit breakers, switches, meters, ground fault protection, starters and other equipment to be included as an assembled part of a switchboard shall comply with the paragraphs where those items are specified.

2.3 MOTOR CONTROL CENTER:

- A. Motor control center shall consist of completely enclosed self-supporting metal structures bolted together to form a dead-front, free-standing rigid assembly.
- B. Each assembly shall comply with or exceed the minimum applicable NEMA Standards for the class of equipment specified. All structures shall be UL listed.

- C. The units shall be of the manufacturer's standard construction for a NEMA Class I, Type B wiring assembly, front accessible [and arranged for back-to-back] mounting. Each structure shall be so designed that the units may be readily removed or future structures added as required, and shall be equipped with a channel iron base. All exterior and interior steel surfaces of the assembly shall be properly cleaned and finished with the manufacturer's standard ANSI gray colors over a rust-inhibiting phosphatized coating. Each motor control center shall be arranged for cable entry at the top or bottom as shown on the drawings. All internal cable connections within each motor control center shall be made up using compression type lugs between cable and terminal fittings. All spaces shown in the motor control center shall be suitable for future fusible starter units, or fusible switches as designated on the drawings. Provide horizontal wireways at top and bottom and vertical wireways.
- D. The motor control centers shall be arranged for operation on a 480 volt, 3 phase, 3 wire, service, unless otherwise noted on drawings. The bus structure shall have a short circuit rating of 42,000 amp rms. Bus shall be of sufficient size to limit the temperature rise to 55EC. in an ambient of 40EC.
- E. All bus work within the motor control centers shall be copper. All motor circuit conductors and all other current carrying materials shall be copper. Main horizontal bus shall be of ampacity shown on the drawings. Vertical bus in each section shall be no less than 300 amp if front mounted only or 600 amps in back-to-back mounting. Ground bus shall be copper. Ground bus shall be provided continuous through all sections of each motor control center. All grounding conductor as required per NEC shall be connected to the ground bus.
- F. All starter units shall be of the interchangeable, modular, drawout design. All drawout units shall have tinplated stabs for connection to vertical bus. All fusible switch units shall be capable of being padlocked in both the "on" and "off" positions. Units shall be interlocked to prevent opening the access door unless the switch is "off." Provision for voiding the interlock for authorized inspection shall be provided. Fuses shall be NEMA Class R (rejection) type sized for motor running overload protection as required under "FUSES." Control power circuit shall be disconnected whenever the fusible switch is open. All control power shall be 120 volt, 60 Hz. Provide an individual control power transformer for each starter unit, with dual fused primary connected on load side of respective switch unit. The control transformer 120 volt secondary shall have a fuse in one lead and the other lead shall be grounded. All starter units shall have a minimum of two (2) spare normally open and two (2) normally closed auxiliary contacts. All components and wiring within each starter module shall be arranged to be readily accessible for maintenance. Overload heater element shall be sized per the motor nameplate for full load current, the service factor and motor classification by application and temperature rise. For additional requirements of motor starters and accessories, see section "MOTOR STARTERS."
- G. Provide a nameplate for each motor control section and each motor starter as specified in the section "NAMEPLATES." Motor control center submittal shall contain a nameplate schedule.
- H. All factory and field-made terminal connections shall be checked in the field prior to energizing the units. Manufacturer shall verify correct field mounting of overload heaters and setting of adjustable controls.

2.4 CIRCUIT BREAKERS:

- A. General: [Breakers 400 ampere frame and larger shall be solid state trip (SST) type unless other special types are indicated on drawings. Breakers with smaller than 400 ampere frames may be thermal magnetic trip (TM) or SST type unless otherwise indicated on drawings.] [Thermal magnetic breakers rated 200 ampere and larger shall have adjustable instantaneous trip.] [Circuit breakers [in outdoor locations] shall be ambient compensated]. Mounting height of breaker operating handles shall not exceed 6-1/2 foot above floor (consider housekeeping pad for floor mounted gear when determining the measurement).
- B. Solid state trip breakers (SST) shall be insulated case or molded case type, ratings as indicated equipped with ambient insensitive solid-state trips, with current sensors and solid-state logic circuits integral to the circuit breaker frame. Settings shall be sealable to prevent tampering.

Long time delay
Continuous Ampere Setting
Short time pickup
Short time delay
Short time I²T pickup
Instantaneous pickup
[Ground fault pickup]
[Ground fault delay]

- C. [Ground fault protection for solid state breakers shall be integral and shall have tripping devices, sensors and a test button allowing testing without tripping the breaker. Provide all other accessories shown, or needed for proper operation.]
- D. [Current limiting breakers (CLN) shall be fuseless type current limiters and shall be molded case type.]
- E. [Automatic type molded case switch (MCS) with magnetic trip element calibrated to protect the switch when subjected to high fault currents.]
- F. Short circuit interrupting capacity shall be as indicated on the drawings and shall in no case be less than [10,000 at 120/240 volts] [14,000 RMS at 480 volts] RMS symmetrical amps at the applied voltage.
- G. Breakers shall be molded case bolt-on type, except where other types are indicated or specified. Clamp-on, push-on, or plug-in type are not acceptable. Removable handle ties and dual, quad or tandem breakers are not acceptable. Mounting hardware, accessories, faceplates, and enclosures shall be provided as necessary for the intended use.
- H. Ground fault circuit interrupter (GFCI) type circuit breakers shall occupy the same space in a panel as a conventional breaker of the same rating and shall have a push-to-test button on the front. A ground current of 5 milliamps (±) or more shall trip the breaker in less than 1/40 second, Each outlet on a GFI circuit shall be tested after installation and results of the test submitted in writing to the Architect.
- I. Special breakers, such as [fused or non-fused] current limiter type, [and] motor circuit protectors (magnetic only) type, [and electronic type,] shall be provided as shown on the drawings. Circuit breakers for special applications such as transfer switching, remote open (shunt trip) or close, or other purpose specified or shown elsewhere shall have all of the features and hardware necessary for the application.
- J. Submittal shall include interrupting capacities in RMS symmetrical amps at the applied voltage. Letter designations are not sufficient.

- K. Light duty commercial/residential type thermal magnetic breakers. Use only in Panels (not in Power Panels). General Electric TQB/THQB.

2.5 DISTRIBUTION PANELS:

- A. Panelboards shall be metal-enclosed, dead front type with sections joined together to form one assembly. Assembly shall consist of group mounted devices arranged so that they may be removed or interchanged from the front of the panel without disturbing the adjacent devices. Provide full capacity bus full height of panel with filler panels for unused portion of panel. Ties between sections shall be bussed. Busbars shall be braced for the available short circuit current indicated.
- B. General Electric CCB, or equal for 208/120V, or 480/277V panels.
- C. Busbars shall be copper. Provide copper equipment ground bus. When indicated on drawings, provide panel with neutral busbar sized for at least [100%] [200%] of phase busbars.
- D. Provide a nameplate for each panel indicating its designation (such as "DISTRIBUTION PANEL DP-1" in 1/4 inch high letters) as indicated on drawings, the voltage system (such as "208/120V-3PH-4W"), and origin of feeder (such as "FED FROM SWBD MSB"). Provide a nameplate for each circuit breaker unit indicating the load served (such as "PANEL A").

2.6 PANELS:

- A. Panelboards for lighting and miscellaneous power shall be the dead front safety type equipped with bolt-on circuit breakers of the numbers and sizes shown on the drawing and herein. Multiple pole breakers shall have an internal common trip. Tie handles will not be permitted. Breakers serving multiwire branch circuits passing through fixtures, shall be multiple pole breakers, even if indicated as single pole on the drawings. Breakers shall have a SWD listing. Provide GFCI type breakers as indicated on drawings and when required by Code.
- B. General Electric type AQ, or equal for 208/120V, and General Electric type AE, or equal for 480/277V.
- C. Busbars shall be copper, braced for the available short circuit current, and have the capacities required on the plans by not less than the ampere frame size of the protective device supplying the panelboard. All panelboards shall be equipped with a copper equipment ground bus. When indicated in panel schedule, provide an oversized neutral comprised of split neutral busbars and each half shall have the same ampere rating as the phase busbars and be equipped with double lugs. Termination lugs shall be rated for 75 degrees C.
- D. Each branch circuit shall have a permanently fixed number. Provide a typewritten directory mounted in a metal frame with a clear plastic front cover on the inside of the cabinet door giving the circuit number and a complete description of all outlets controlled by each panel circuit breaker. Consult Owner's representative for correct room and/or furniture system module designation scheme (not necessarily those shown on drawings). Mark "spares" with pencil only and leave "spaces@ blank.

- E. Provide a nameplate for each panelboard indicating the panel designation (such as "PANEL 3A") as indicated on drawings, the voltage system (such as 208/120V-3PH-4W"), and origin of feeder (such as "FED FROM SWBD MSA").
- F. Special panelboard construction or features shall be as shown on drawings. For circuit breakers, switches, contactors and other equipment to be included as an assembled part of the panelboard, refer to the paragraph where those items are specified. [Panels for exterior use shall have weatherproof enclosures.]
- G. Refer to Paint, Finishes and Colors subsection.
- H. Doors shall be fastened to trim with concealed hinges and provided with flush type combination catch and lock. All locks shall be keyed alike. Mount floor standing panelboards on a base. Refer to Concrete Equipment Bases subsection.
- I. Where panelboards are shown mounted free-standing, provide an angle iron or unistrut rack suitably braced to support these panels.

2.7 POWER PANELS:

- A. Power panelboards shall conform to Panels subsection requirements except as modified hereinafter. Breakers of the light duty commercial/residential (quick-lag) type are not acceptable.
- B. General Electrical CCB, Westinghouse type PR3 or PR4, or equal for 208/120V, and General Electric CCB, Westinghouse type PR3 or PR4, or equal for 480/277V.

2.8 MINI-POWER CENTERS:

- A. Mini-power centers shall be three phase units 480 volt primary and []; volt [] phase secondary.
- B. All transformers shall have a minimum of 2-5% full capacity primary taps below normal and shall be rated 115EC temperature rise above 40EC maximum ambient. All insulating materials are to be in accordance with current NEMA ST20 standards for a 185EC UL component recognized insulation system.
- C. Transformers are to be encapsulated using a sand-epoxy resin mixture to provide maximum protection against moisture, dust and corrosive environments.
- D. Package power supplies shall include integrally mounted and wired primary and secondary circuit breakers in accordance with the National Electric Code.
- E. Branch circuit breakers shall be plug-on type, Square D type "Q0", or equal. Trip indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF".
- F. A hinge access door shall be provided which maintains itself in the open position when desired and which has padlock provisions.
- G. Mini-power centers shall be U.L. listed.

2.9 SAFETY SWITCHES:

- A. Externally operated switches shall be quick-make, quick-break, with interlocking cover. Switches and enclosures shall be [heavy duty type] [for fused switches and normal duty type if for disconnect service only]. Provide Class [J] [RK1] rejection clips if used with fuses. Switches used in indoor dry conditions shall have NEMA 1 enclosures. Switches exposed to wet or outdoor conditions shall have [non-metallic NEMA 4X enclosures.] [NEMA 3R enclosures.]
- B. Provide a nameplate on each disconnect switch as specified in "NAMEPLATES". Nameplate shall show item controlled, voltage, phase, and source of power.
- C. In case of a substitution of material or equipment protected, the disconnect, fuses, circuit conductors, conduit, conduit and feeder circuit breaker shall be resized accordingly and provided at no additional cost.

2.10 MAIN FUSIBLE SWITCH:

- A. The main fusible switches shall be quick-make, quick-break. Switches shall have plug-on line side connections. Each switch is to be contained in a separate steel enclosure. The enclosure will employ a hinged cover for access to the fuses which will 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 released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the "OFF" position and the operating handle position shall give positive switch position indication, i.e.: red for "ON" and black for "OFF". Switches shall pass industry standard 1²t withstandability tests and fuse tests as described elsewhere in the specifications.

2.11 BOLTED PRESSURE SWITCHES:

- A. Switches shall be complete with all mounting hardware and faceplates and shall be dead front with an external operating handle having provisions for 3 padlocks. Manufacturer nameplates shall be visible from the front when the switch is installed and shall include name, rating in continuous volts and amps, and fault rating.
- B. Fuses shall be current limiting sized as shown on drawings. The fuse compartment access door shall be interlocked with the switch.
- C. Closing the switch shall be firmly bolt or press the movable blades to both top and bottom stationary contacts. Operation shall be quick make and quick break. Arc tips and chambers shall be replaceable stationary type.
- D. Provide a nameplate as specified under "NAMEPLATES".

2.12 GROUND FAULT PROTECTION - SWITCHBOARD MOUNTED:

- A. The ground fault protection equipment shown on the drawings shall be factory installed and tested by the switchgear manufacturer and shall be the same manufacturer as the switchboard circuit breakers and switches.
- B. Fault protection equipment shall include sensors, relays, pick-up and time delay selectors, test buttons, tripping devices in breakers and switches, and all wiring and connections.

- C. Sensors shall be zero sequence current transformers encasing all phases and the neutral [of each circuit protected] and arranged to respond only to ground fault current [in that circuit]. [Conductors shall be centered in the window with suitable spacings maintained.]
- D. Relay shall be draw out, solid state type having the ground fault current pickup adjustable in the field for various levels between 200 and 1200 amps to the value shown on the drawings to [] amps. The time delay shall be adjustable in the field to various levels between .1 seconds and .4 seconds. Settings shall be [as shown on the drawings] [pickup []A, time delay [.] seconds.]
- E. A test button shall be provided either as a part of the relay assembly or in a separate test panel. Wiring shall be arranged to allow testing without tripping the breaker or switch.
- F. Manufacturer shall provide a transformer, complete with fusing, installed and connected in the switchboard. The ground fault protection equipment and the trip devices shall operate from this @ 120 volt 60 hz supply.
- G. Provide a nameplate for each relay identifying the breaker or switch controlled.

2.13 FUSES:

- A. Fuses for feeders and motor branch circuits shall be time delay current limiting type with 200,000 AIC. The time delay shall be minimum 10 sec. at 500% load for 600A or smaller fuses and 4 sec. at 500% load for larger than 600A. 600 amp. and smaller fuses shall be class [J] [RK1]. Fuses larger than 600 amp. shall be class L.
- B. Upon Owner's acceptance of the electrical distribution system, provide the Owner's representative with spare fuses and cabinet to hold same as follows: Three fuses of each rating installed 601 amperes and larger, 10% of each type and rating installed 0 to 600 amperes but not less than three of each. Fuses shall be provided in a 24" X 30" 6"D [] spare fuse cabinet where noted on the drawings. Fuse cabinet shall have hinged, key lockable door with engraved nameplate. Written documentation shall be submitted by the Contractor and approved by the [Owner's representative] prior to completion of project.
- C. Fuse sizes shown on drawings are for reference only based on specified mechanical/plumbing equipment. Final determination of fuse sizes shall be made by Contractor based on approved mechanical/plumbing equipment nameplate ratings.
- D. Fuses shall be installed so that the rating can be clearly read from the front of the open switch without removing the fuse.

2.14 MOTOR STARTERS - INDIVIDUALLY MOUNTED:

- A. Starters used in indoor dry conditions shall have NEMA 1 enclosures. Starters exposed to wet or outdoor conditions shall have [non-metallic NEMA 4X] [NEMA 3R gasketed] enclosures. Provide a nameplate for each starter unit indicating the load served (such as "EXH. FAN E-1").

- B. Magnetic: Shall be combination starters. Provide with a motor circuit protector unless specifically indicated on drawings to be with a fused switch. Provide accessories (start/stop pushbuttons, H.O.A. switches, red neon pilot running lights, interlock contacts, control transformer, etc.) as required by this Division and by Division 15 - Mechanical plans and specifications. Confirm ratings (watts, volts, amps, etc.) with mechanical control system supplier prior to ordering of components. Each starter unit shall, as a minimum, have in its cover an overload reset, hand-off-auto selector switch and a red pilot running light. Equip each starter unit with the number of auxiliary N.O. and N.C. contacts required but at least four N.O./N.C. convertible contacts. Equip each starter with an overload relay in each undergrounded wire. Select overload ratings to match the characteristics of the motors actually installed. Refer to 16800 - "Utilization Equipment". Control voltage shall be [120V] [per mechanical documents] except for external mechanical control circuits. Source shall be unit transformers in each starter compartment. Transformer shall be 100 VA minimum rating.
- C. Manual: Toggle type with integral melting alloy overload protection. Where shown on the drawings, fractional horsepower motors shall have toggle type manual starters with thermal overload protection in each phase. Provide a padlocking-off device on the handle, and where the motor is out of sight of the switch provide a pilot light in the cover to indicate switch is closed.

2.15 CONTACTORS:

- A. 20 amp, [ampere rating as shown on drawings] mechanically held with coil clearing feature or electrically held as indicated on drawings.
- B. Separate enclosures shall be NEMA I for interior dry locations and NEMA 3R [] for exterior or damp locations, or as otherwise shown on the drawings, with [finish as required for panelboards.] [manufacturer's standard finish.]
- C. [Contactors or relays for remote circuit control work specified in Division [17] [] shall be selected and rated for the proper voltage, loads, and type of duty. Mounting shall be either in a separate compartment of the panelboard cabinet, or where wall space permits, in a separate cabinet adjacent to the panelboard. Compartments and cabinets shall conform to the specification for panelboard cabinet work and shall be sized for adequate mounting and wiring space. Controls and wiring shall be as specified in Division [17] [].]
- D. New contactors or relays for existing switchboards or panelboards shall be by the same manufacturer as those existing in the board or by the manufacturers listed above.
- E. Provide nameplates for each contactor or relay identifying the item controlled as specified under "NAMEPLATES".

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall conform to the requirements of the NEC and to the manufacturer's shop drawings and mounting instructions. Equipment base for floor standing equipment shall have an adequate number of anchor bolt holes to put the base in direct contact shear and tension with the mounting surface at all anchor bolt locations. Refer to Section 16300 "Basic Materials and Methods", for seismic restraints requirements.

3.2 GROUNDING:

- A. Grounding and bonding shall be in accordance with Section 16400, "Wiring Methods, Raceways and Conductors."

END OF SECTION

SECTION 16300 BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:

- A. Material List and Manufacturer's Literature

1.2 CUTTING AND PATCHING:

- A. Perform drilling, cutting, and patching of the general construction work whether existing or new, which may be required for the installation. Patch with the same materials, workmanship and finish as the original work and accurately match all surrounding work. Such work shall be done by a craftsman accredited in the applicable trade and be acceptable to the Owner's representative.

PART 2 - PRODUCTS

2.1 IDENTIFICATION SYSTEMS:

A. Nameplates:

- a. Provide nameplates for safety switches, switchboards, breakers mounted in switchboards, relay cabinets, signal terminal cabinets, individually mounted enclosed breakers, panelboards, starters, timeclocks, remote control switches and similar items. Nameplates shall be laminated black-white-black backlite or phenolic plastic with 1/4-inch high lettering engraved through the outer covering except where specifically described otherwise. Affix with self-tapping machine screws (no rivets or glue). The screws shall not project beyond the backside face of enclosure doors, or panels.
- b. Inscribe as indicated on drawings or herein. If not indicated, the inscription should describe the equipment served.

- B. Refer to DEVICE PLATES for engraving requirements.

- C. Refer to WIRE AND CABLE for tagging and color coding requirements.

2.2 PAINT, FINISHES AND COLORS:

- A. General: Painting requirements of this Subsection are supplementary to the Painting Sections of these specifications.

- B. Switchboards, panels, terminal cabinets, equipment enclosures, wireways, boxes, conduit etc.: Standard grey or galvanized manufacturers finish unless otherwise noted hereinafter.

- a. Exceptions in public areas:

- 1. Flush panels and cabinets: Fronts shall have factory applied primer and field applied oil base semi-gloss enamel finish coat (except metal plated parts) to match adjacent wall surfaces.

2. Surface panels, cabinets and wireways: Same as (a) "Flush panels" except also paint the enclosure (can) using the same paint as is on adjacent surface in lieu of semi-gloss paint. Apply etching compound (galvanized surfaces) and undercoater prior to finish coat.
 3. Surface and Flush Boxes: Paint to match adjacent surfaces as described in (b) "Surface panels".
 4. Exposed conduit: Paint to match adjacent surfaces as described in (b) "Surface panels".
- C. Ferrous metal miscellaneous parts (except stainless steel): Galvanized in accordance with ASTM A123 or A153.
- D. Lighting fixtures in public areas: Standard manufacturer's finish except as modified by LIGHTING Section, including Fixture Schedule. Exception: Paint the trims of recessed fixtures to match adjacent wall or ceiling surface if so directed by Owner's representative.
- E. Wiring devices, device plates and floor boxes in public areas: As specified in WIRING DEVICES and DEVICE PLATES Subsections.

2.3 WIRING DEVICES:

- A. Acceptable Manufacturers: Pass & Seymour, Hubbell, Leviton, Arrow Hart, or equal.
- B. Switches:
- a. AC general use snap switches shall be toggle handle, quiet operating, [specification] grade, UL listed [and verified to meet Federal Specification W-S-896 and NEMA WD-1 heavy duty tests.]
 - b. Switches shall be rated 120/277 volts 20 amps. Switches shall have HP ratings as follows:
20 amp rating - 1 HP @ 120V, 2 HP @ 240V.
 - c. Toggle handle color shall be [ivory] [white] [selected by Architect].
 - d. Switches shall be constructed with [oversized] silver-cadmium alloy contacts, permanent lubrication, and binding head screws suitable for #10 AWG wire. Connection shall be made by wrapping the wire around the screw or tightening a screw clamp. Push-in type connections are not acceptable. Switches may have built-in pigtail connection in lieu of screw connection. [Switches shall have means for grounding.]
 - e. Switches shall be Pass & Seymour #20ACI, Hubbell CSB120I, or equal.
 - f. Keyed and momentary contact switches, required but not listed, shall be of the same manufacturers and identical quality as those listed above.
 - g. [Illuminated mushroom pushbuttons for cooktop, range and shop power shut-down shall be 2 1/4" diameter, red, equal to Square 'D' 9001 series, mounted on stainless steel plate. Provide red engraved plate with 1/4" high white lettering above pushbutton to read: []. Plate shall be fastened with (4) screws, one at each corner.]
- C. Receptacles:

- a. Receptacle outlets shall be [Premium Specification Grade], [Specification Grade] [Premium Specification Grade Safety type] of standard NEMA configuration.
- b. General receptacle outlets shall be [15] [20] amp, 125 volt, 2 pole, 3 wire. The attachment screw shall have an automatic grounding clip. A green grounding screw shall be mounted on the bridge which shall run around the back of a break and impact resistant plastic body. The bridge shall be securely locked to the body. Outlets shall be UL listed and verified to meet Federal Specification WC 596 and NEMA WD 1 heavy duty performance tests. Contacts shall be [extra heavy duty] copper alloy or bronze double wipe type. Outlets shall have binding head screws suitable for #10 AWG wire. Connection shall be made by wrapping the wire around the screw or tightening a clamp. Push-in type connections are not acceptable. Outlets may have built-in pigtail connection in lieu of screw connection.
- c. Receptacle outlet fronts shall be [ivory] [white] [selected by Architect].
- d. Outlets shall be Pass & Seymour [5362-I] [5352-I] [SG-63-H-I] [Hubbell HBLSG63], [or equal].
- e. Ground fault circuit interrupter (GFCI) outlets shall be specification grade 20 amp duplex grounding receptacle suitable for mounting in a standard outlet box. A ground current of 5 milliamps \pm shall trip the circuit open in less than 1/30 second. There shall be a test button and a reset button on the front. Each GFCI outlet shall be tested after installation and results of the test submitted in writing. GFI receptacles shall be Pass & Seymour #2091-SHG-I, [or equal].
- f. Industrial type outlets shall be by Crouse-Hinds, Appleton, or Russellstoll, and shall be rated for the amps, volts, poles, and wires indicated on the drawings.
- g. Isolated ground receptacles shall be 20 amp 125V, 2P, 3W grounding type manufactured by Pass & Seymour [IG6300] [or equal]. Provide each isolated ground duplex with stainless steel engraved plate to read: "ISOLATED GROUND", Pass & Seymour #S-8-IG, [or equal].
- h. Transient voltage surge suppressor receptacles shall absorb up to 80 joules of energy either from hot to neutral, hot to ground or neutral to ground. Receptacles shall come with surge suppression indicator. Device shall provide isolated ground capability. Receptacle shall be Pass & Seymour #IG-6362-OSP, [or equal].
- i. Special power outlets, not listed above, shall be standard NEMA configuration as noted on drawings and shall be of at least equal grade and quality to those listed above.

2.4 DEVICE PLATES:

- A. Acceptable Manufacturers: Pass & Seymour, Hubbell, Leviton, Arrow Hart, or equal.
- B. Plates for flush wiring devices, including telephone outlets, shall be [smooth, high impact, thermoplastic, [type 302 stainless steel] [type 430 stainless steel]]. Wiring devices and device plates shall be the same manufacturer. Color shall be [ivory] [white] [selected by Architect].
- C. Provide switch and device plates with engraved designations wherever called for by words, set off in quotation marks near a switch location, or by symbol. If inscription is not detailed on drawings request it from the Owner's representative. Engraving shall be in 1/8-inch high block type letters filled with black enamel.
- D. Finish plates for all surface mounted devices shall be pressed steel galvanized. Cover plates for flush mounted junction boxes in finished areas shall be selected by Owner's representative.

- E. For surface interior outlet and junction boxes of the pressed steel knockout type, use 1/2-inch raised galvanized steel plates for devices and flat galvanized steel for blank plates.
- F. Provide a plate for each outlet, receptacle, switch, device and box.
- G. [Receptacle plates shall be labeled on the back side of the plate with a tape designator (Kroy, Brother or equal) indicating the panelboard designation and circuit breaker number serving the device.] Each switch, receptacle device, etc. which is installed in an outlet box with coverplate shall have the panel and circuit number [labeled on inside face of coverplate with either embossed tape or indelible pen.] [engraved with 1/8" high black filled lettering at top of coverplate.]
- H. Plates for exterior [roof] locations shall be metallic with gaskets and shall have [lockable] [nonlockable] weatherproof spring loaded covers for devices, [Pass & Seymour #WPH-26L.] [Pass & Seymour #WPH-26,] [or equal].
- I. Plates for exterior wall locations shall be key lockable, heavy duty hinged type. Pass & Seymour #4600-[8] [26] or series, or equal.
- J. Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked "Suitable For Wet Locations While In Use" and "UL Listed". A gasket shall be provided between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base. TayMac #10310 or equal.
- K. Plates for exterior wall locations shall be key lockable, heavy duty hinged type, or equal. Taymac #10370.
- L. Ganged devices shall have gang plates exactly matching the arrangement and quantity of devices. All plates shall fit the box perfectly with no field modification necessary. Plates on surface mounted boxes shall not overhang the box. All plates shall be manufactured specifically for the type of outlet, device and box to which they are applied.

2.5 TERMINAL CABINETS:

- A. Cabinet boxes shall be of finish construction as specified for panelboards, same manufacturer as panelboards, and shall conform to the requirements of Underwriter's Laboratories, Inc., Standard for Cabinets and Boxes. Trim, doors and flush catch shall be of construction similar to that specified for panelboards. Provide terminal cabinets with 3/4-inch plywood backboard.
- B. Size shall be as shown on the drawings. Partition barriers shall be provided in cabinets between 120 volt signal circuits and fire alarm terminations, and all low voltage signal circuit terminations.
- C. Pull ropes in spare ducts shall be tagged identifying the system and its destination, i.e.: "Fire Alarm - To PB-3". Tagging shall be as specified for power and signal feeders in Section 16400.
- D. Cabinets and fronts shall be constructed the same as panelboards and shall be finished to match panelboards. Doors shall be lockable and shall be keyed to match the panelboard.

- E. All cable and wiring entering or leaving the signal cabinet shall be tagged, denoting its system, destination and origin, i.e.: "Fire Alarm - To/From: Building_____." This shall be plastic nameplates with plastic tie wrap as specified in this Section.
- F. Tags shall be engraved nameplates, see Section 16300 - "IDENTIFICATION SYSTEMS". Tags shall be fastened to conductors, or cables tightly with plastic tie wrap.
- G. Cabinets shall be complete with terminal block directory which identifies each termination by system and circuit number. Directory shall be laminated in plastic and permanently fastened to inside of cabinet door.
- H. Wiring diagrams shown on the drawing for the various systems are to show basic operation of systems and are not necessarily suitable for construction of the panels.

2.6 EQUIPMENT CABINETS:

- A. Cabinets shall be factory constructed and finished and shall be [free standing] [wall mounted] [mounted on a frame] [mounted as detailed on the drawings]. Dimensions shall be [as shown] [or as required to contain the components mounted inside].
- B. Construction shall be of angle iron or formed steel framework with steel panels enclosing all except the bottom. No raw or sharp metal edges shall be visible. Enclosures shall be constructed to UL standards for switchboards.
- C. Finish shall be [manufacturer's standard cataloged] [ANSI 61 or 49 enamel over primer] for [indoor] or [outdoor] use. [Finish for outdoor enclosures shall] [be Munsell] [Outdoor Green #7.OGY3.25/1.5] [Light Gray #5.0GB7.0/0.4] [match transformers and other exterior switchgear] [Finish shall be applied by the manufacturer.]
- D. Enclosures installed outdoors or exposed to weather shall have hinged front doors with vault type padlockable handles and three point latches. All openings shall be suitably designed to prevent the entry of weather, dust, animals and foreign matter. [A lighting fixture, switch and duplex convenience outlet shall be factory installed and connected inside each weatherproof cubicle containing switching devices. [or instruments.]] Light shall be located to illuminate nameplates and operating handles.
- E. [Securely anchor enclosure to the pad, floor, or wall to conform to [seismic standards specified under "EARTHQUAKE REQUIREMENTS".] [details shown on the drawings.] [details provided by the equipment manufacturer.]]
- F. [Securely anchor enclosures to a channel iron base which shall be furnished complete by the enclosure manufacturer. Bases shall be drilled and tapped to receive the enclosure and shall be fastened securely to the floor or pad. Fill the entire base with grout and finish smooth. Enclosures shall be secured in accordance with the [paragraph "EARTHQUAKE REQUIREMENTS".] [details shown on the drawings.] [details provided by the equipment manufacturer.]]
- G. Provide a full size [3/4" thick plywood backboard] [mounting pan] inside for mounting equipment.
- H. Provide a nameplate on the exterior and plates for each item of equipment inside as specified under Section 16300 - "IDENTIFICATION SYSTEMS".
- I. After installation the enclosures shall be carefully cleaned. Any damaged paint shall be retouched with matching paint provided by the manufacturer.

2.7 BACKBOARD:

- A. Type AC, Interior grade, 3/4-inch thick plywood with exterior waterproof glue. Mount with "A" side out. Prime and then paint with 2 coats of semi-gloss oil base enamel to match color of adjacent surface. Backboards shall be used only in interior locations.
- B. Securely mount backboard to wall structure. Use expansion anchors in masonry and concrete, sheet metal screws supplemented with toggle bolts in drywall with metal studs, and wood screws supplemented with toggle bolts in drywall with wood studs.
- C. Neatly arrange equipment on board and attach to board with round head wood screws.

2.8 LIGHTING CONTROL CABINETS:

- A. Cabinets shall contain all components required for proper operation of the system shown. Install flush or surface as shown on the drawings.
- B. Fronts shall match panelboards. Cabinets shall be galvanized or painted steel where recessed, and finish matching the front where surface mounted. Fronts shall be secured with machine screws set flush, and doors shall have flush hinges and latches with locks to match panelboards.
- C. Provide an identification nameplate as specified in Section 16300 - "IDENTIFICATION SYSTEMS".
- D. Wiring diagrams shown on the drawing for the various systems are to show basic operation of systems and are not necessarily suitable for construction of the panels. Exact wiring diagrams shall be mounted or provided on the inside of the cabinet.

2.9 PHOTOELECTRIC CONTROLS:

- A. Photoelectric controls shall be Intermatic, Precision Multiple, Paragon, [or] Tork [, or equal].
- B. [Control unit shall be three prong twistlock type plugged into a [matching base mounted in a luminaire or conduit, as applicable.] [Control unit shall be a direct wire weatherproof unit for conduit or box mounting and shall have a sliding shield adjustment for light admission to the element.] [Provide an angle mounting bracket where shown as wall mounted.]
- C. Control shall have a [high impact plastic] weatherproof housing with a hermetically sealed light sensitive element. Contacts shall be rated for a minimum ballast load of 1800 VA at the applied voltage and shall be [open] [closed] when deenergized. A surge arrestor shall be built in. Turn on shall occur at 1-3 footcandles and off at 3-10 footcandles. Unit shall have a time delay of approximately 15 seconds and shall meet IEEE-NEMA standards.

2.10 TIME SWITCHES:

- A. Time switches shall be Intermatic, Paragon, or Tork, [, or equal]. Time switches controlling lighting shall have spring wound carry overs and astro dials.

- B. Timeclock shall be rated or 40 amps per pole [SPST] {DPST} [3PST] []; [120] [208] [277] volts. Contractor shall set timeclock to turn lights On and Off at times designated by the owner or their representative.
- C. Enclosures shall be NEMA I for interior dry locations and NEMA 3R for exterior or damp locations. Doors shall have padlock provisions. Finish shall be [manufacturer's standard.] [ANSI 61.]
- D. Provide a nameplate on each unit indicating items controlled as specified in "NAMEPLATES."

2.11 ELECTRONIC TIME SWITCHES:

- A. Time switches shall be a Paragon [EC71] [EC72] [EC72/ST] [EC77] [or equal] , [1] [2] [7] [] circuit programmable time control with the following features:
- B. 365 day per year programming to control lighting circuits for daylight savings periods, 16 events per day, or 112 events per week per channel, power outage carryover powered by lithium battery.
- C. Voltage shall be [120] [277].

PART 3 - EXECUTION

3.1 EQUIPMENT DISCONNECTS:

- A. Provide equipment disconnect switches as indicated on drawings and as required to conform to Code. Safety switches shall be horsepower rated when used with motors. Toggle switches and toggle type manual motor starters without overload protection shall be used, within their ratings, in lieu of safety switches for motor disconnects where shown on the drawings.

3.2 INSTALLATION OF OUTLETS AND EQUIPMENT:

- A. All outlets, wall switches or wiring devices may be located within a radius of twelve feet from original location shown on plans at no additional charge to the Owner if such request is made prior to installation of the rough-in for the item.
- B. Accurately place outlet boxes independently and securely fasten to the structure and, in concealed work, provide with plaster rings and set flush with finished surface of walls or ceilings.
- C. Coordinate the location and mounting heights of wall-mounted receptacles, fire alarm and signal devices switches with casework, shelving, furniture, and other equipment shown on Architectural and Interiors drawings and Americans with Disabilities Act (ADA), UBC, ANSI, and all other applicable codes governing the project. Conflict between electrical and architectural drawings shall immediately be brought to the attention of the Owner's representative for resolution before the installation of the devices.
- D. Outlet and junction boxes for interior use shall be galvanized, one-piece pressed or welded steel, knockout type, except where other types of boxes are indicated or specified. In masonry or concrete construction waterproof boxes manufactured for that purpose shall be used. Plastic, fiber or composition boxes will not be permitted.
- E. Protectively cover all devices, outlet boxes, cabinets, etc., before plastering and painting.

3.3 CONCRETE HOUSEKEEPING BASES FOR EQUIPMENT:

- A. Floor standing switchboards, transformers, cabinets, and similar equipment shall be mounted on concrete bases.
- B. Bases shall be 1-1/2 inch high and shall extend 1-inch beyond edge of equipment unless specifically indicated otherwise. Verify size of equipment before fabrication of base.

3.4 FIRE RATED SEPARATIONS:

- A. Where electrical equipment or materials of this Division penetrate fire separations, maintain the integrity of the separation by providing Code approved fire rated penetrations or by providing an enclosure around the penetration which effectively continues the separation. Refer to other sections of this Division for supplementary requirements to these basic requirements.

3.5 SEISMIC RESTRAINTS:

- A. Provide the work in compliance with the most stringent seismic requirements for Zone 4, of applicable Codes including the Title 24 and California Code of Regulations (CCR) Uniform Building Code, but with the requirements herein as minimum standards. Provide seismic restraints for materials and equipment of this Division, including (but not limited to) the items listed below. The attachments shall resist forces applied to the center of gravity of the components. Criteria shall be the operating weight of the item times .5g for horizontal forces and .33g for vertical forces. Design for the horizontal force to be applied in any direction. Wall mounted or suspended components shall, in addition, resist a downward force of 200 pounds minimum added to the operating weight.
 - a. Switchboards, transformers, and all free-standing panels or cabinets and similar equipment.
 - b. Suspended lighting fixtures.
 - c. Lighting fixtures integral with ceiling or directly mounted to ceiling.
 - d. Suspended conduit hangers and trapezes.
 - e. Cable tray.
- B. Suspended electrical conduit, 2-1/2" nominal size and larger, shall have individual hangers not longer than 12" from the top of the pipe to the bottom of the support for the hanger. If a longer hanger is used, Contractor shall apply seismic restraints. Supporting calculations and details shall be submitted for Title 24 compliance review.
- C. Four 12 gauge hanger wires shall be provided to each recessed troffer one located at each diagonal corner. In addition troffers shall be fastened with two self tapping screws at each end of fixture through housing to main runners of the T-bar grid. Installation of these screws shall in no way deform the fixture housing. Provide spacers between the fixture housing and the T-bar grid where required.
- D. Provide bracing and anchorage of conduit hangers and trapezes in accordance with SMACNA published "Guidelines for Seismic Restraints of Mechanical Systems".

- E. Pendant, suspended, or stem mounted lighting fixtures shall have approved earthquake resistant hangers if code required and have movable joints at ceiling and fixture when more than one stem is used per fixture. In addition, fixtures shall have steel stranded aircraft cable attached to the structure and to the fixture at each point of support, in addition to the fixture hanger. Cables shall be installed slack and shall be capable of supporting four times the vertical load. The fixture shall be capable of swinging 45E in any direction. Where a 45E swing would cause the fixture to strike a wall or other object, suitable cables or other means of bracing shall be added to prevent the fixture from swinging against the other object.
- F. Carefully review the space available to insure that the restraint systems proposed will not impair the required equipment clearance, working space or access.
- G. Submit details of the seismic anchorages and receive approval of the Owner's representative prior to installation. Details shown on the drawings are for reference only and may not be suitable for the actual equipment to be installed. Exception: Details for seismic anchorage may be omitted for equipment installed on a floor or roof and weighing less than 500 lbs, but the installation shall be subject to the approval of the Owner's representative.

3.6 WORK IN EXISTING SWITCHBOARDS AND PANELBOARDS:

- A. Existing switchboards and panelboards shall be modified as indicated on the drawings. The specifications for new switchboards and panelboards shall apply to work in existing except as otherwise indicated.
- B. New components such as circuit breakers, switches, relays, and contactors shall either be of the same manufacturer and type as existing in the board or shall comply with paragraphs where those items are specified.
- C. New bolted connections shall be torque tightened as recommended by the manufacturer of the equipment.
- D. Provide or replace nameplates, tags or labels as required. Install new circuit directories in all panels where changes are made or where directories are not correct. Provide new plastic cover if existing is missing.
- E. Finish on new faceplates and components shall match existing as closely as possible.
- F. Where new panel interiors or components are provided, submit shop drawings as required under "SUBMITTALS."

3.7 CHECKING AND TESTING OF EQUIPMENT AND SYSTEMS:

- A. Switchgear, panels, disconnects, contactors, transformers, and other equipment installed under this section shall be inspected for defects, and tested for proper operation.
- B. Enclosures and cabinets shall be checked for cleanliness inside and out and for defective or damaged finish.
- C. Systems shall be tested for short circuits, open circuits and wrong connections and shall be free from mechanical and electrical defects. Circuits shall be tested for proper neutral, phase rotation, and ground connections. [Ground rods shall be tested for resistance and a report submitted listing each rod by location and its resistance to ground.]
- D. [The ground fault protective system shall be performance tested by passing a current through the

toroid causing the correct breaker to trip as intended. The Division of Industrial Safety shall be notified well in advance of the test date so that their Engineer may supervise the ground fault system testing if he wishes.]

- E. [GFCI outlets and GFCI branch circuit breakers shall be tested by applying a ground current of 5 milliamperes, ± 1 ma, which shall trip the unit off in less than 1/40 second. Each test shall be recorded and the record shall include the type of test equipment used, results of test, location of device tested, date of test, and name of test technician. "Test" button operation shall be successfully demonstrated but will not be acceptable as a substitute for the trip test described.]
- F. Where required or directed, systems shall be tested in the presence of the Owner to demonstrate that equipment furnished, installed or connected functions in the manner intended.
- G. The Contractor shall furnish all necessary instruments and equipment and all power sources and connections required for making required tests, and shall immediately correct any defective work at no additional charge.
- H. Bolted connections shall be torque tightened to manufacturer's specifications.
- I. [An on-site test shall be made of the illumination levels in the area designated under "SITE LIGHTING LUMINAIRES," for which a computer-generated FC level layout was submitted. Tests shall be conducted by the Contractor and observed by the []. Contractor shall demonstrate that the illumination produced at any location in the area is equal to the level indicated at that point in the computer-generated layout. Contractor shall furnish and operate for the test a meter reading in footcandles and shall certify that the meter has been calibrated within 30 days to a standard known to be accurate. The [] shall be given not less than [10] [] days of notice by the Contractor and the date and time shall be mutually agreed upon. The test shall be conducted after dark and after not less than [12] [] actual installed hours of burn-in time of the new luminaires. Spot tests of any or all other new lighting areas shall be conducted as directed by the []. If the results of the illumination level tests are not satisfactory or not in substantial conformance with the approved computer-generated FC level layout, the [] may require the Contractor to replace the luminaire with one of the specified manufacturers or install additional, or larger, luminaires at no additional cost.
- J. For additional checking and testing of systems see the Sections where those systems are specified.

END OF SECTION

SECTION 16400
WIRING METHODS, RACEWAYS AND CONDUCTORS

PART 1 - GENERAL

1.1 SUBMITTALS:

- A. Material List and manufacturers literature.

1.2 ACCEPTABLE MANUFACTURERS:

- | | |
|--|--|
| A. Metallic conduit | Triangle, PWC, Allied Tube & Conduit Co., Wheatland, [or equal]. |
| B. Non-metallic conduit | Carlton, CertainTeed, Pacific Western, [or equal]. |
| C. Liquidtight flexible conduit | American Brass Co., Columbia Cable and Electric Corp., International Metal Hose, Appleton, [or equal]. |
| D. Conduit bodies and City, fittings | Appleton Electric, Crouse Hinds, Thomas & Betts, Steel Gedney Electric Mfg. Co., [or equal]. |
| E. Floor boxes | Walker, Lew, Steel City, Hubbell, Thomas & Betts, Russell and Stoll, [or equal]. |
| F. Wireways | Square D, Hoffman, Nepco., [or equal]. |
| G. Wire and cable (600V) | Cablex, Anaconda, Okonite, Paranite, Circle, Phelps-Dodge, Simplex, General Cable, Cyprus-Rome, Pirelli, Triangle, [or equal]. |
| H. Wire pulling compound | Minerallac, Wyrease, Ideal, [or equal]. |
| I. Solderless connectors and lugs | Burndy, OZ, T&B, Dossert, [or equal]. |
| J. Cable Supports | OZ, PLM, [or equal]. |
| K. Underground Pullboxes, Handholes and Manholes | Associated Products, Brooks, [or equal]. |

PART 2 - PRODUCTS

2.1 CONDUITS:

A. General:

- a. Types and applications shall be in conformance with Codes and with this specification.

- b. Minimum sizes: 3/4-inch underground or in concrete except that 1/2-inch is permissible where such a run terminates in a box containing a single wiring device. 3/4-inch minimum for homeruns.
- B. Types:
- a. Rigid steel conduit (RSC) and fittings: Hot-dip galvanized.
 - b. Intermediate metallic conduit (IMC) and fittings: Same finish requirements as for rigid steel.
 - c. Electrical Metallic Tubing (EMT) and fittings: Same finish requirements as for rigid steel. Use permitted only in dry, concealed locations (above suspended ceilings and inside stud walls) and interior exposed locations (10 feet minimum above floor) where not subject to mechanical damage. Fittings: Liquid tight compression gland type, malleable iron or steel. Steel City #TC715 or T & B #5123 series [or set screw type, T&B or "ETP"], or equal. [Set screw fittings will not be acceptable]. Die cast or pressure cast fittings will not be acceptable.
 - d. Flexible steel conduit and fittings: Flexible conduit shall be galvanized steel and shall be used where shown on the plans and to connect conduit systems to motors, direct wired and vibrating equipment, and as a final connection to lighting fixtures in accessible dropped grid type ceilings. Flex shall not be used as a wiring system instead of EMT. Flex shall be used instead of EMT only where EMT would be impossible to use in interior dry frame or stud construction in conformance with codes and ordinances [and where permission is granted upon request, by the Architect]. Flexible conduit shall have a code sized grounding conductor run with it and shall have approved grounding fittings. Where used in damp or wet locations flexible conduit shall be of the liquid tight type with outer neoprene jacket and suitable liquid-tight fittings. Fittings: "Jake" or malleable iron squeeze type.
 - e. Liquidtight flexible steel conduit and fittings: Same finish requirements as for flexible steel conduit except PVC jacketed. Use in lieu of standard flexible conduit in damp or wet locations and for connections to motors. Fittings: Appleton ST series or American Brass Sealtite type U.A., or equal.
 - f. Rigid aluminum conduit (RAC) and fittings: May be used in lieu of EMT for sizes over [1"] [] in interior, dry, above ground locations only. Fittings shall be suitable for aluminum and shall be of the threaded type.
 - g. Rigid plastic conduit (RPC) and fittings: Shall be used for underground work. Plastic conduit for direct burial shall conform to NEMA TC-2 and shall be PVC equal to Carlon Type EPC-40. Plastic conduit for concrete encased burial of sizes 1-1/2" and smaller shall conform to NEMA TC-2 and shall be PVC equal to Carlon type A-EPT. For concrete encasement of sizes 2" and larger, plastic conduit shall conform to NEMA TC-6 and shall be equal to Carlon P&C duct type EB. Types named are minimum acceptable for the applications indicated. Conduit, fittings and solvent cement shall be produced by the same manufacturer and shall be chemically and mechanically compatible.

C. Installation - General:

- a. Continuously check the work of the other Divisions to prevent any interference between the various installations. Should structural difficulties or work of other Divisions prevent the routing of conduit as indicated on the drawings, make necessary deviations therefrom as directed by the Owner's representative.
- b. Route conduit so as to clear beams, plates, footings and structural members, whether or not indicated on the plans. Do not run conduit through any structural member of the building, except as specifically directed by the Owner's representative. Under no circumstances run conduits through column footings or grade beams.
- c. Conduit installed in concrete work shall be carefully laid and rigidly supported in the forms in such a manner as to provide proper clearance so that all boxes and outlets will be in exact locations after concrete has set and forms have been removed.
- d. Concrete slabs on grade: Conduit shall not be installed in slab on grade.
- e. Where conduit penetrates a fire rated separation, any of the following packing methods may be used to restore the integrity of the separation if Code approved: cement, mineral fiber sprayed with a flame retardant coating, or Dow Corning 3-6548 RTV silicon foam, 3M caulk #CP25, 3M putty #303, or equal. Seal shall be water tight and shall be accomplished prior to wire pulling.
- f. Where a conduit enters building through the concrete foundation wall or floor below ground water level, a watertight entrance seal shall be used. These seals shall be O.Z. Type "FSK" or "WSK", or as equal.
- g. Do not run conduit closer than 6-inch to any uninsulated hot water or steam pipe, heater flue or vent. If pipe is insulated, the clearance may be reduced to 2-inch. Provide condulets for exposed runs of conduit where junction, bends or offset are required, whether such condulets are indicated on the plans or not. No bends are permitted around corners, beams, wall or equipment. No running threads are permitted. Run a die over factory threads to ensure that they are clean and free from all coating material and that good metallic contact with the fittings is obtained. Paint the exposed portion of field cut threads with a suitable zinc rich paint.
- h. Upon completion of each run of conduit, test the run and clear it of all obstructions. Plug each conduit end with conduit pennies and bushings or manufacturers seals until ready for pulling wire. Provide a 200 pound test nylon or polypropylene pull rope in each empty conduit, tie off rope at each end, and provide an identification tag on rope at each end.
- i. Where panelboards and cabinets are installed flush in walls, extend empty conduits from panel to an accessible space above or as indicated on plans. Provide a minimum of one 3/4-inch conduit for each three single pole spare circuit breakers or spaces, or equivalent, but not less than three conduits.
- j. All Fire Alarm system conduits shall have a 2" wide band of red paint every 10 feet along the length.

D. Installation - Above Grade:

- a. All conduit above grade or inside of a structure shall be metallic, except in masonry and concrete walls schedule 40 may be used.
- b. Run conduit concealed, except as otherwise indicated.
- c. Run exposed conduit parallel with or at right angles to walls or as directed by the Owner's representative.
- d. Where conduits are placed in partitions necessitating cutting of any structural member, provide supports as directed by Owner's representative in accordance with applicable structural requirements.
- e. Locate conduit so as not to obstruct access or service to equipment.
- f. Conduit passing through the roof: Flash and counterflash and/or provide a prefabricated flashing boot as manufactured by Stoneman, or equal. Method shall be compatible with roofing system and acceptable to the Owner's representative.
- g. Conduit 1-inch and smaller over metal channel for lath and plaster or acoustical ceilings shall be tied to the supporting channels with 12 gauge galvanized tie wire spaced at a maximum of 10-foot intervals. Conduits shall not obstruct accessibility of ceiling or removal of panels. Do not use ceiling wires for support. Support exposed conduit 1-inch and smaller from building with T & B, or equal, pipe straps spaced at a maximum of 10-foot intervals. Attach supports with machine screws, nuts and lock washers in metal; wood screws in wood; and expansion shields or inserts in masonry or concrete. Perforated strap iron shall not be used. Conduits larger than 1-inch shall be suspended on pipe racks with Grinnell No. 107B, or equal, split-ring hangers and rods from concrete inserts.
- h. RSC shall be installed in interior wet locations, exposed exterior locations, and wherever specifically shown. [Where installed in exterior locations in contact with the earth, RSC and fittings shall be encased in PVC coated for corrosion protection.] Conduit, from slab to bottom of surface mounted panelboards, distribution panels, device outlet boxes, terminal cabinets, where exposed, shall be RSC. Conduit concealed in wall from slab to flush mounted panels, distribution panels, terminal cabinets, and all device outlet boxes for all systems shall be EMT except to devices mounted at 36" or less in which case flexible conduit may be used. Contractor shall be allowed a dimension of 3 inches above slab to make transition from PVC to EMT, flex or rigid steel as allowed above.

E. Installation - Underground:

- a. Bury underground conduit (except under buildings) to a 24-inch minimum depth below finish grade to top of conduit or concrete envelope (when encased). Deeper burial depths shall be as indicated on drawings, or as required to meet minimum spacing from other utilities lines and obstructions.

- b. Encasement:
1. Concrete: [Provide a 3-inch thick (minimum) concrete cover around conduits below grade. Provide not less than 2-inch of concrete between adjacent conduits in the same encasement except that power conduits shall be separated 3-inch minimum from signal (control/instrumentation/ communications/public telephone) conduits. Concrete shall be minimum of 2000 psi.]
 2. Sand: [Provide a 3-inch thick (minimum) sand cover around conduits below grade. Provide not less than 2-inch of sand between adjacent conduits in the same encasement except that power conduits shall be separated 12-inch minimum from signal (control/instrumentation/communications/public telephone) conduits.] Sand for electrical conduit encasement shall be construction type with minimum grade of SE-30.
 3. Provide non-metallic spacers and chairs to prevent deflection of the conduits. For concrete encased duct banks, tie conduits to spacers and anchor to prevent floating or displacement during pouring of concrete.
 4. Exception: Provide utility service conduits in accordance with this Section and with serving utility requirements except that the portion underground beyond 5-feet from the building need only meet serving utility and Code Requirements.
 5. Exception: (Branch Circuit Conduits 1-1/4 and smaller sizes): PVC Schedule 40 may be installed below floor slab or paved roadways or parking lots with 6-inch of sand around in lieu of concrete encasement. [PVC Schedule 40 may be installed below grade in unpaved or planted areas with 6-inch of sand envelope and 2-inch 2000 psi concrete cap on top, in lieu of concrete encasement.]
- c. Risers to grade shall be PVC coated rigid galvanized steel unless otherwise noted. Exception: Risers to base of exterior lighting poles may be PVC schedule 40 plastic conduit.
- d. The ends of all underground conduits entering buildings shall be capped or sealed with acceptable compound, such as Crouse Hinds "Chico A", or equal, after installation of wire. Cap empty conduit stubouts at both ends. In landscaped areas, terminate in a waterproof J-box.
- e. Provide a plastic warning tape in the backfill over the ductlines approximately 12 inches below grade. Tape shall be run continuously along the entire length of the underground utility lines. Tape shall be polyethylene plastic manufactured specifically for warning and identification of all buried utility lines. Tape shall be of the type provided in rolls, 6-inches minimum width, color coded for electric lines (red), and communications (orange) with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. [Tape shall consist of top and bottom layers of B-721 polyethylene or polyester with a center metallic foil core suitable for locating by a conventional detector at the specified depth.] [Tape shall be by Thor Enterprises, Brady, Seton, or equal.] Submit data sheets as specified under "SUBMITTALS".

- f. Conduit Location Markers: Conduits stubbed or capped-off underground shall have their location identified with a concrete marker 6" x 6" x 12" high with a flush brass plate set in the 6" face. Identification of the conduit shall be stamped or engraved into the plate and the marker set [flush with finished grade.] [4" above finished grade.] Show exact location of markers and identification markings on as-built drawings. Submit data sheets as specified under "SUBMITTALS".
- g. Excavated materials not required or unsuitable for backfill shall be removed from the project site. Provide sheeting and shoring as necessary for protection of work and safety of personnel. Remove water from excavations by pumping or other approved method.
- h. Backfill shall be placed in layers not more than 6" thick and each layer shall be compacted. Backfilling shall progress as rapidly as the construction, testing and acceptance of the work permits. Backfill shall be free from roots, wood, scrap material, and other vegetable matter and refuse. Compaction of backfill shall be to [95 percent of maximum density.] [80% of ASTM D method "D" maximum density.]
- i. Backfill around underground structures such as manholes or handholes shall consist of earth, loam, sand, clay, or sand and gravel, free from large clods of earth or stones over one inch size. Backfill materials shall be placed symmetrically on all sides in loose layers not more than nine inches deep. Each layer shall be moistened, if necessary, and compacted with mechanical or hand tampers to 90 percent compaction.

2.2 UNDERGROUND PULLBOXES:

- A. Handholes (less than 24" X 36") for exterior underground use shall be reinforced, precast, concrete electrical type.
- B. Boxes shall consist of a body, cover, [extension] [and base,] with clear interior dimensions as shown on the drawings.
- C. Covers shall be [as shown] [concrete] [cast iron] [steel plate] with finger hole] [bolt down] [traffic] type. [Covers shall be traffic type where installed in driving or parking locations, and non-traffic elsewhere] All exposed steel shall be [galvanized.] [painted gray.] [Concrete covers shall fit flush and without rocking. Chipped, cracked, or badly fitting covers will not be acceptable.] All bolts shall be stainless steel.
- D. Mark all covers with permanent raised or depressed letters reading ["Electrical] ["Parking Lighting"], ["Ground Rod"] [Signal"] or applicable designation. No abbreviations.

2.3 UNDERGROUND HANDHOLES:

- A. Pullboxes (24" x 36" or larger) for exterior underground use shall be reinforced, precast, concrete electrical type.
- B. Boxes shall consist of a body, cover, [extensions], [and base,] with clear interior dimensions as shown on the drawings.

- C. Covers for 24" X 36" pull boxes shall be 1 piece, bolt-down type. Covers for 48" X 48" or larger pull boxes shall be two piece torsion hinged type. Covers shall be parkway or traffic as called for on drawings with galvanized steel checkered plate with angle frame. All exposed steel shall be galvanized. All bolts shall be stainless steel. Mark all covers with permanent raised or depressed letters reading "Electrical", "Signal", or applicable designation. No abbreviations.

2.4 MANHOLES:

- A. Manholes shall be precast concrete type with interior dimensions as shown on the drawings. Manufacturer shall be Associated Concrete Products (Quickset), [or] Brooks Products [, or equal]. Each casting shall be identified by having the manufacturer's name and address cast into an interior face or permanently attached thereto.
- B. Provide a complete assembly including cover, frame, collar, neck, top section, body sections, and base section. Provide a sump in the base section. [Drain facilities shall be installed as shown on the drawings.] Top entry shall be in center of cover. Clear interior dimensions shall be as shown on the drawings [or as required by the utility].
- C. Castings shall be reinforced, 3000 PSI minimum strength concrete and shall be rated for AASHTO Class H20 wheel loading.
- D. Provide, as a minimum, the following accessories and features:
- E. Cast iron or steel frame and cover. Cover shall be minimum 27" diameter and 100 lbs. weight, and shall have holes suitable for lifting or barring. There shall be a cast or welded designation on the top of the cover to clearly identify the manhole as ["power"] [or] ["telephone"] [or] ["communications"]. [High voltage manholes shall have covers that read: "DANGER HIGH VOLTAGE - KEEP OUT".]
- F. Steel ladder, complete with mounting hardware. Ladder and hardware shall be zinc coated after fabrication and shall extend high and low enough for convenient entry and exit.
- G. Pulling-in irons cast into walls opposite each duct bank and into floor below the cover. Irons shall project approximately 4" into the manhole and shall be zinc coated after fabrication.
- H. Ground rod, 3/4" x 10'-0", copper clad steel, located along one side or in one corner.
- I. Cable rack brackets on each wall spaced not more than 24" horizontally. Cable hooks and insulators shall be provided to accommodate the number of power cables shown on the drawings, [plus an additional set for each spare conduit that can provide cable passage through the manhole]. [Where communication cables are shown provide enough sets of hooks and insulators to accommodate those shown.] [Where communication cables are not shown provide one set of hooks only.] Metallic parts shall be zinc coated after fabrication.
- J. Manholes provided for the use of a serving utility shall meet all requirements of and shall be approved by the utility.

2.5 WIREWAYS AND WIRING GUTTERS:

- A. Construct of galvanized sheet steel which has been primed and given a final coat of grey enamel. Covers shall be hinged and fastened with brass machine screws spaced not more than 12-inch apart. When covers are on the bottom, provide removable wire supports not more than 3-ft. apart. Sections shall be securely attached to each other and to cabinets, boxes, or duct to insure ground continuity. Provide copper equipment grounding conductors throughout the wireway system. Securely attached or support the wireway or gutter from the building structure at points no more than 4-feet apart. Size shall be as indicated on drawings unless larger is required to conform to NEC standards. When suspended from roof or ceiling, the support spacing shall be not more than 4-feet and 3/8-inch diameter rods shall be used. When attached to wall, use expansion anchors in masonry and concrete, sheet metal screws supplemented with toggle bolts in drywall with metal studs, and wood screws supplemented with toggle bolts in drywall with wood studs.
- B. Power gutter assemblies: Mount gutter to a 3/4-inch plywood backboard. Gutter and backboard shall be sized to accommodate the equipment. Arrange equipment neatly and symmetrically on backboard.

2.6 MULTI-OUTLET ASSEMBLIES:

- A. Multi-outlet assemblies shall be factory built and field assembled 2-piece surface raceways having outlets in the cover and shall be installed where shown on the plans. Exact mounting height and installation shall be coordinated closely with other trades involved.
- B. Multi-outlet assemblies shall be Wiremold #2000-"GA" series or equal, with outlets [12] [18] inches on center and [ivory] [buff] finish.
- C. Isolated ground multi-outlet assemblies shall be Wiremold #2000-"IG" series constructed of steel with outlets spaced [12] [18] [] inches on center and [ivory] [buff] finish.
- D. Outlets shall be specification grade, NEMA 5-15R, single, grounding, pre-wired type, spaced as shown on the drawings.
- E. Wiring shall be 2 circuit with outlets alternately connected. Provide a code sized, insulated, grounding conductor throughout, code sized for the largest circuit. Connect to each outlet.
- F. Systems shall be complete with all required matching fittings, couplings, bases, covers, boxes, and other material which shall be designed and manufactured to be used together without modification except for cutting bases and covers to length.
- G. For the field wired type, raceways shall be Walker, or Wiremold [3000] [4000] [500] [6000] [with] [without] barrier, with number of outlets, devices, and conductors shown.
- H. Provide dividers where 2 or more systems are shown to be installed in one raceway.
- I. Wiring shall be field installed and shall be as specified under "Wire and Cable". Provide an insulated grounding conductor throughout, code sized for the largest circuit. Connect to each outlet.
- J. Outlets and devices shall be field installed in the raceway and shall be as required by the specification paragraphs for the types of outlets and devices shown.
- K. Outlet and device covers shall be provided by the raceway base manufacturer specifically for

the types of outlets and devices shown on the plans. Covers between outlets shall be blank. Covers for cable exit shall have insulating grommets.

- L. Pre-wired assemblies, field wiring, outlets and devices shall be installed in the base sections and held in place with clips and brackets before the cover sections and plates are installed.
- M. All runs shall follow the horizontal and vertical building lines. Work improperly fitted, tightened, aligned or mounted will not be acceptable.
- N. Systems shall be complete with all required matching fittings, couplings, bases, covers, boxes, and other material which shall be designed and manufactured to be used together without modification except for cutting bases and covers to length.
- O. Submit components for review as required under "SUBMITTALS".

2.7 SURFACE RACEWAY SYSTEMS [-1 PIECE TYPE]:

- A. [One piece] surface raceway systems shall be installed [where shown on the plans] [and in finished spaces where wiring cannot be concealed. Utility rooms, equipment rooms, shops, rough storage rooms, and similar spaces are excepted].
- B. Raceways, boxes, and fittings shall be [Walker, or] Wiremold [200] [500] or [700] [, or equal] [as suitable for the number and sizes of wires shown or required].
- C. [Type 200 systems may have 1 piece cover and box.] Types 500 and 700 systems shall have separate boxes, covers and devices; location and type as shown on the drawings.
- D. Wiring shall be as specified under "WIRE AND CABLE". [Provide an insulated grounding conductor throughout code sized for the largest circuit. Connect to each outlet.]
- E. Outlets, devices and covers shall be as required by the specifications for the outlet or device types shown.
- F. Systems shall be constructed of cold rolled galvanized steel [or new extruded aluminum]. Finish [for steel] shall be [buff], [ivory] [or gray, but not mixed,] factory applied [ANSI 49 (powder)] paint. [Finish for aluminum shall be [satin anodized clear.] [natural brushed.]
- G. Systems shall be rigidly supported with [concealed fasteners, straps shall not be used] [straps and fasteners.]
- H. Systems shall be complete with all required matching fittings, couplings, bases, covers, boxes, and other material, which shall be designed and manufactured to be used together without modification except for cutting bases and covers to length.
- I. All runs shall follow the horizontal and vertical building lines. Work improperly fitted, tightened, aligned or mounted will not be acceptable.
- J. See plans and details for special application or installation of raceways.
- K. Submit data sheets as required under "SUBMITTALS".

2.8 UNDERFLOOR TRENCH AND DUCT SYSTEMS:

- A. Furnish and install a complete underfloor trench and duct system for power, telephone, and data located, constructed, and arranged as shown on the plans.

- B. The system shall consist of steel trenches with covers, raceways, junction boxes, and outlets complete with all couplings, supports, inserts, elbows, and caps, adapters and other fittings, devices and hardware necessary for a complete integrated system.
- C. Manufacturer shall be Walker, Square D, or equal. All components shall be by the same manufacturer and shall be designed for assembly as a system.
- D. Power duct shall be Walker #2, Square D "standard", or equal. Telephone and data duct shall be Walker #4, Square D "super", or equal. Ducts shall be blank or have inserts as shown on the plans. Inserts shall be 24" on centers. Inserts shall be capped and plaster-of-paris poured and set in each cap before concrete is poured. The first and last insert on each run shall have a marker screw set flush with the finished floor surface.
- E. Junction boxes shall be arranged for duct entries as shown on the plans. Covers shall be adjusted flush and shall have linoleum, tile, or carpet pans where applicable. Provide blank-off plugs for unused duct entries.
- F. Trenches shall consist of base sections with barriers as shown, and an adjustable upper assembly. Base section and barriers shall be minimum 14 gauge galvanized steel. Upper adjustable assembly shall consist of minimum 15 gauge galvanized steel telescoping side panels, side screen strips, and flat coverplates. Upper assembly shall be designed to be continuously supported independent of adjusting screws, side screens, and telescoping side panels shall be mechanically locked into concrete fill to allow no movement or vertical adjustment of coverplate after concrete has set. Coverplates shall be fabricated from 1/4" thick steel plate, hot dip galvanized after fabrication and roller leveled again after galvanizing. Plates shall be true and level, in easily handled sections, and gasketed along the supporting members. Plates shall be held in place during concrete placement with flat head, countersunk machine screws. Replace stock screws with special stainless steel flathead screws for finished installation. Provide a tapped hole at each corner of each plate for insertion of lifting screws. Provide an adjustable double trim at edges of plate and along each side of trench. Trim shall be aluminum or stainless steel of a proper height to finish flush with floor covering. Verify type of floor covering to be used. Trim strips shall be attached to upper assembly independent of coverplates.
- G. Trench and duct systems shall be accurately aligned and securely braced before concrete pour. Top of duct inserts shall be set by transit 1/8" below finished floor level. Duct and trench supports shall be set on brick or concrete pads and staked in place. All joints in the system shall be sealed with approved tape or waterproof compound so that no foreign material or moisture can enter the system trenches and ducts. Ducts shall be set with clearance for a minimum of a 2" concrete envelope around sides and bottom. Concrete shall be carefully placed to assure that the components remain in exact position and that a complete envelope is formed with no voids.
- H. Insert markers and hold-down screws shall be set in escutcheons and shall be pulled down tight to the floor covering so that the edges cannot be felt.

- I. Provide service fittings as shown on the plans. Electrical floor outlets shall be Walker #513 AL-DPS-G, Square D #G2-CA, or equal. Telephone outlets shall be Walker #507-AL, Square D #G5-100, or equal.
- J. Receptacles shall comply with the specification for "RECEPTACLE OUTLETS".
- K. Submit shop drawings as required under "SUBMITTALS".

2.9 CABLE TRAY SYSTEMS:

- A. Cable tray shall be by Mono-Systems, Inc., MP/Husky Corp, TJ Cope Inc, Square D Co, US Gypsum (Globe), or equal.
- B. Cable tray shall be of a type, width, and depth as shown on the drawings. Provide all sections, fittings, plates, divider, covers, clamps, and hardware as shown or required for the application. Rung spacing shall be [] [6"] unless shown otherwise.
- C. Tray shall be suspended from secure and substantial structural members by means of threaded rod and manufacturer supplied hanger hardware attached to manufacturer supplied brackets or attached to channel and threaded rod assemblies. Rods shall be minimum of 3/8" diameter. Supports shall be not more than 6 feet apart with 2 rods at each support point, except that Mono-Systems tray shall have single 1/2" rods at not more than 6 feet apart.
- D. Provide a cable drop out assembly for each 5 feet of tray installed. Locate drop out as directed during installation.
- E. Submit components for review as required under "SUBMITTALS".

2.10 OUTLET, JUNCTION AND PULL BOXES:

- A. Outlet boxes, junction boxes and covers shall be galvanized one-piece pressed steel knockout type. Exception: Exposed conduit boxes shall be cast metal if connected to rigid or intermediate conduit.
- B. The size of each box for lighting outlets shall be determined by the number of wires or conduits, or size of conduits, entering the box but shall be not less than 4-inch square and 1-1/2 inch deep, unless prohibited by structural conditions.
- C. All junction boxes on the drawings shall be minimum 4-11/16-inch square by 2-1/8-inch deep.
- D. Provide pull boxes and junction boxes where indicated on plans or where required by Code. Size to properly accommodate conductors with Code requirements as minimum. When necessary pull and junction boxes are not indicated on drawings and are to be placed in a public space, coordinate the location with the Owner's representative. Boxes of outlet box size which are in public spaces shall be flush mounted and shall have single gang ring and blank device plate painted to match adjacent surface.
- E. Equip outlet boxes with plaster rings and extension as may be required. Provide manufactured "far side box supports", which shall be in contact with the gypboard surface behind the box.

- F. For local switch outlets, provide 4-inch pressed steel boxes with switch plaster rings for one or two gangs. Where 2 gang, 20-ampere or larger switches occur, provide 4-11/16-inch square boxes with switch plaster rings.
- G. For convenience outlets, etc., provide 4-inch square pressed steel boxes, or larger if necessary, with single gang plaster rings.
- H. Use approved factory-made knockout seals in all boxes where knockouts are not intact.
- I. Use offset bar hangers fitted with fixture studs to support outlet boxes in stud partitions and in furred or plastered ceilings.
- J. Outlets for wall mounted telephones shall be in outlet box which is securely fastened to structure.
- K. Boxes for in-floor flush outlets shall be cast iron, concrete tight Hubbell #B2436 [or equal]. Multi-gang floor box shall be used where indicated on the drawings. There shall be minimum of 1-1/4" external height adjustment and minimum 3/8" internal final adjustment. Top flange shall be rectangular and adjusted flush with the finished floor. Provide brass tile flanges. Cover shall be brass duplex flap type, equal to Hubbell #S3825 [or equal] for power, and brass 2-1/8" single type, equal to Hubbell #S2825 [or equal], for telephone, signal and data systems, [and Soundolier MRB [or equal] series for projector and microphone jacks.] Single and ganged floor boxes in carpeted areas shall be provided with clear polycarbonate carpet flange. Outlets shall be as specified in "RECEPTACLE OUTLETS".
- L. In masonry or concrete construction waterproof boxes manufactured for that purpose shall be used.
- M. Ganged boxes shall be used whenever possible where drawings show outlets grouped at single location.

2.11 WIRE AND CABLE - over 600 volts:

- A. Cables for use on [2400] [4160] [] volt system shall be [single conductor] [3] [4] conductor [5] [15] [] KV, 90C [] rated, conforming to ICEA [S-66-524] [S-68-516] and UL [1072].
- B. Conductors shall be [copper] [aluminum] [] class B stranded per ASTM B8. Strand screen or shield shall be semi-conducting tape or extruded compound. Insulation shall be [cross-linked polyethylene (XLP)] [ethylene propylene rubber (EPR)], minimum [215] [225] mil, [100%] [133%] insulation, [grounded] [un-grounded]. Insulation screen, or stress control layer, shall be semi-conducting tape or extruded compound. [Shielding shall be copper [wires] or [tape] served helically over the insulation screen.] [Jacket shall be [PVC] [or] [Polyethylene].
- C. Manufacturer shall be Anaconda, Cyprus/Rome, Essex, Okonite, [or] Pirelli [, or equal].
- D. High voltage terminations shall comply with the requirements of IEEE Standard 48, hand wrapped stress cones, tapes or pennant type or "slip-on" stress cones rated for use with cable provided. The termination material shall be the product of one manufacturer who shall furnish all components in the form of a kit which includes complete instructions which shall be followed for fabrication and installation. Termination shall include stress relief cones and shield grounding.
- E. High voltage cable splices shall be made using a kit which shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable which is

to be spliced. Splices shall be made only in accessible locations.

- F. Submit cable, termination, and splice materials as required under "SUBMITTALS".
- G. Installation of Wiring - over 600 volts:
 - a. Terminations of insulated power cables shall be protected from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as designated by the written instructions of the cable manufacturer and termination kit manufacturer. Terminations for high voltage cables shall be rated in accordance with and be capable of withstanding test voltages in accordance with the IEEE standard publication 48 and shall be supported to prevent strain on terminals.
 - b. High voltage splices shall be made using a "kit" of all materials necessary for making the complete splice. The "kit" shall be the product of one manufacturer and shall have the approval in writing of the manufacturer of the cable which is to be spliced. Splices in shielded cables shall include covering the splice area with metallic tape of like material to the cable shield and by connecting it to the cable shield on either side of the splice by soldering. Provide a #6 bare copper ground connection.
 - c. Where cable is exposed in manholes, pullboxes, trenches, cabinets and pull sections strips of fireproofing tape shall be wrapped tightly around each cable spirally in one half-lapped wrapping, or in two butt-jointed wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable and shall extend one inch into the ducts. To prevent unraveling, the fireproofing tape shall be random wrapped with pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with a flame retardant, flexible, polymeric coating and/ or a chlorinated elastomer. The tape shall be not less than 0.050 inch thick and shall weight not less than 2.5 pounds per square yard. The tape shall be non-corrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.
 - d. The Contractor shall make tests on the high voltage cables after installation which shall be in accordance with the requirements of the appropriate IPCEA "Voltage tests after installation" paragraph in the particular specification for the cable involved. The Engineer shall be notified at least three working days in advance of the Contractors proposed date of the tests to permit witnessing of the tests. The Contractor shall submit copies of the results of the tests.

2.12 WIRE AND CABLE (under 600 volts):

- A. General: Deliver wire and cable to the site in their original unbroken packages, plainly marked or tagged with UL label, size and insulation type, and manufacturers name.
- B. Conductors: Soft drawn copper, solid for No. 10 AWG and smaller, stranded for No. 8 AWG and larger or for connections to vibrating equipment or control wiring. Minimum size No. 12 except as noted. Aluminum cable will not be permitted.
- C. Insulation: Thermoplastic type THHN, THWN. Provide high temperature insulations in abnormally high ambient temperatures as applicable. Equipment and electrode ground wires may be uninsulated in conformance with codes, and where indicated.
- D. Connections and Terminations:

- a. Use Pressure indenter type or self-threading spring wire connectors for sizes up to the catalog capacity of the connector. 3M Scotchlok, Ideal Supernut, Buchanan B-Cap, or equal.
 - b. Use clamp type pressure connectors complete with clip held insulating cover for large sizes or capacities. As manufactured by Burndy, O.Z., T & B or equal.
 - c. Wrap joints with two layers of plastic tape, half lapped, Scotch No. 33. Underground (below grade) splices shall be epoxy encapsulated.
 - d. Wiring in underground pullboxes shall be spliced using compression connectors and resin encapsulation kits, 3M Scotch-cast, or equal; or shrink tubing kits. Splices shall be completely waterproof.
 - e. Bolted connections to equipment or busbars shall be made with approved solderless compression type or set screw type lugs for wires No. 8 AWG and larger. Special connections shall be as shown on the plans. Binding screws may be used for size No. 10 solid and smaller.
- E. Installation of Wiring Under 600 Volts:
- a. Install wiring in conduit unless noted otherwise. Raceways shall be clean and dry before cable installation.
 - b. Do not use mechanical devices for pulling No. 2 AWG and smaller wire. Torque limiting types may be used for No. 1 and larger sizes but tensions shall not exceed cable manufacturer's recommendations.
 - c. Pulling compound: Minerallac #100, Wyrease, Ideal 77 Yellow, or equal.
 - d. Form wire into pigtail splices with 8-inch leads for connections to wiring devices and fixtures.
 - e. Any new or existing wire damaged as a result of installation or removal of wire under this Section, shall be pulled out and replaced with new at no additional charge. Any existing wire found to be damaged or inadequate shall be called to the attention of the Owner.

F. Color Coding:

- a. General: Insulation for wires No. 6 and smaller shall be factory color coded and for larger sizes where available from the factory. When factory color is not available provide 1-inch band of colored pressure sensitive tape at each splice and termination point. Colors shall be consistent throughout the respective system and shall be identified as follows:

b.

<u>System</u>	<u>A Phase</u>	<u>B Phase</u>	<u>C Phase</u>	<u>Neutral</u>	<u>Equipment Ground</u>
120/240V 1 ϕ 3W	Black	Red	-	White	Green
120/240V 3 ϕ 4W	Black	Orange	Blue	White	Green
240V 3 ϕ 3W Black	Red	Blue	-	Green	
120/208V 3 ϕ 4W	Black	Red	Blue	White	Green
277/480V 3 ϕ 4W	Brown	Orange	Yellow	Gray	Green w/stripe
480 3 ϕ 3W	Brown	Orange	Yellow	-	Green w/stripe

- c. Control, low voltage, and other systems shall have distinctive coloring different from above.
- d. Isolated ground for conductors system shall be green with a yellow stripe or green marked with yellow tape.
- e. Control Circuits:

Hot Lead (usually to stop pushbutton)	Red
Common return	Yellow
Main coil (usually to start pushbutton)	Brown
Reset coil	Blue
Trip coil	Orange

- G. All branch circuit conductors shall have their circuit numbers identified with tape labels on each phase conductor. Identification shall be provided at each outlet box, junction box, panelboard, contactor cabinet, or similar location.
- H. [Engraved nameplates shall be provided on each power and communications system feeders in underground pull boxes. Nameplates shall be fastened to feeders with plastic tie wrap. Description shall indicate origin voltage and destination of feeder, i.e: "From MSB to Panel HZA voltage, 277/480 volts".] This same tagging method shall be applied to all pull ropes in empty spare conduits. Tags for pull ropes shall include origin and destination of each conduit.
- I. Any conductors or signal cables left unconnected shall be identified by labeling with their intended use, circuit number, or other suitable information. All power and communications conductors or cables shall be tape identified denoting circuit or zone numbers with tape type labels on each conductor of circuit or cable.

2.13 MANUFACTURED WIRING SYSTEM:

- A. Manufactured wiring systems for branch circuit wiring of lighting fixtures in demountable acoustic tile ceilings, shall be Dualite, Reloc or AFC, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF UG HANDHOLES, PULLBOXES, AND MANHOLES:

- A. [Pullboxes], [handholes], [manholes], and ducts shall be assembled and installed in strict conformance with the manufacturer's instructions.
- B. Pullboxes with open bottoms shall be set on a minimum of 12" deep sand base to allow for drainage. [Handhole] and [manhole] base sections shall be set on a minimum of 6" compacted and leveled rock or sand to ensure even distribution of soil pressure on base. Top of covers and manhole rings shall be flush with final grade or paving and shall be perfectly level.
- C. A preformed joint sealing compound of non-hardening mastic furnished by the handhole or manhole manufacturer shall be placed in the grooves of the base and body sections to seal the sections together watertight. Joints shall be carefully cleaned before sealing.
- D. Concrete encased duct lines connecting to handholes or manholes shall be constructed to have a tapered section adjacent to the manhole to provide shear strength. Manholes shall be constructed to provide for keying the concrete envelope of the duct line into the wall of the manhole. Vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the manhole.
- E. Provide end bells for all duct terminations in pullboxes and manholes.
- F. Backfilling around structures shall consist of earth, loam, sand-clay, or sand and gravel, free from large clods of earth or stones over one inch in size. Backfill materials shall be placed symmetrically on all sides in loose layers not more than nine inches deep. Each layer shall be moistened, if necessary, and compacted with mechanical or hand tampers to 90 percent compaction. [Surfaces disturbed during the installation of [pullboxes], [handholes] and [manholes] shall be replaced as described under paragraph "RESTORATION OF SURFACES".]
- G. After installation, handholes, pullboxes, and manholes shall be cleaned of dirt, sand, and debris and the covers sets in place. Pullropes leaving ducts shall be suitably tagged to allow future identification and use. Location of duct entry shall be marked clearly on as-built plans for pullboxes and manholes.

3.2 GROUNDING AND BONDING:

- A. Ground and bond the electrical system and equipment in accordance with the most stringent of applicable codes but with the requirements herein and on drawings to be the minimum standards.
- B. Equipment grounding conductors:
 - a. Provide copper THHN, THWN insulated equipment grounding conductors in all raceways.

- b. The grounding conductors shall be provided whether scheduled or shown on the drawings or not, and if necessary the conduit size shall be increased to accommodate them. These grounding conductors shall be connected to the ground terminals on the device or enclosure at each end of the installation and shall be interconnected with the other ground terminals and conductors to form a continuous wired grounding system throughout the electrical wiring system.
- C. Ground rods: 3/4-inch diameter X [8] [10]-feet copper clad steel. Drive full length into earth with the top 3-inch minimum below grade or underside of slab. Where ground rods cannot be driven vertically to the desired depth below grade, they shall be driven at an angle away from or parallel to the exterior wall. When driven parallel to the wall, the angle shall not exceed 45E. The rod shall penetrate to a depth of permanent ground moisture. When ground rods cannot be driven because of bedrock at less than 4 feet below grade level, a counterpoise ground electrode shall be used in place of rods. The counterpoise system shall consist of not less than 50 feet of No. 2 AWG bare tinned copper wire, buried to a depth of at least 18 inches below grade, for each ground rod shown. The wires shall be run in a straight line.
- D. [Ground rods: Where indicated on the drawings as "XIT GROUND RODS", rods shall be XIT rod [#K2-10] [] installed strictly to manufacturer's instructions to achieve an impedance to ground of 5 ohms or less. Rod shall be 2-1/8" diameter, type K copper with wall thickness of .083". Ground clamp shall be suitable for #8 to #3/0 copper cable. Rods shall be installed in drilled holes, located as shown, with the top breather holes of the rod at least 1" above the surface. Resistances shall be tested after rods have been in place for at least a week, and test results submitted immediately afterward to allow time for additional rods to be installed if needed.]
- E. Connections: Connection to [inaccessible] ground rods [below ground] shall be made using [exothermic welding devices,] [ground rod clamps.] [Above ground and accessible connections [shall] [may] be made using ground rod clamps.] [or exothermic devices.] Multiple bolt silicon bronze connectors, Burndy or O.Z. Electric; or exothermic welded, Burndy, Erico Cadweld products, or equal.
- F. Test each grounding electrode for resistance at the connection point before connecting any wires. Resistance at the grounding electrode shall not exceed the following:
- | | |
|-----------------------------|------------------|
| Service equipment | - [25] [] ohms. |
| Interior electrical systems | - [25] [] ohms. |
| Exterior transformers | - [10] [] ohms. |
| Exterior lighting standards | - [25] [] ohms. |
| Computer isolated systems | - [10] [] ohms. |
| XIT rods | - [5] [] ohms. |
| Underground grids | - [5] [] ohms. |
- G. If the above values are not achieved with the installed system notify the Owner's representative.
- H. Each ground electrode shall be tested using a ground resistance megger, or other suitable instrument, in conformance with the manufacturer's directions. Submit a report listing as a minimum the date of testing, name of tester, instrument used, location and type of ground electrode, and resistance in ohms. Submit within 5 days after testing is completed.

- I. Grounding electrode conductors shall be provided for service equipment and transformers by the Contractor. Utility Company transformer grounding shall be installed per Utility Company requirements. Ground conductor connections to transformer shall be by Utility Company.
- J. Flush wall outlets and switches shall have a bonding wire from device ground terminal, or approved mounting screw from strap, to metal box.

3.3 MISCELLANEOUS WORK:

- A. Provide all miscellaneous metal and concrete work required; all core drilling required; all cutting and patching required; all trenching and backfill required; and provide all hangers, anchors, chases, supports, and material required for the installation of the electrical systems.
- B. Touch up or refinish damaged surfaces of panels, switchboards, and equipment, worked under this section, to the satisfaction of the [Architect] [Owner's Representative]. Use paint provided for that purpose by the equipment manufacturer.
- C. All work shall be in accordance with applicable sections of the specifications.

3.4 DEMOLITION WORK AND SALVAGE:

- A. Where an outlet, device or item of electrical equipment is shown to be removed, the entire installation, including boxes and conduit, shall be removed unless otherwise indicated.
- B. Where the structure, finish, fixture, outlet, circuit or equipment is damaged or left incomplete or unworkable due to demolition work, it shall be patched, repaired, replaced, rerouted or relocated as conditions require and as directed by the Architect.
- C. All existing wiring not being reused shall be removed back to the switchboard, panel or first active outlet box. Vacated conduit shall be removed unless removal would damage the structure. Place blank plates on all vacated boxes left in place.
- D. Electrical material which the Contractor is directed to remove that is not specified for reuse on this project shall be [removed from the site] [delivered to the [] storage, except material released to the Contractor. Material released shall become the property of, and shall be removed from the site by, the Contractor. Material to be delivered to the [] shall be carefully removed and transported so as to remain in reusable condition. Materials to be delivered to the [] will include power generators and associated equipment, transformers, reusable lighting fixtures, lamps and poles (both wood and metal), and will not include conduit, wire or non-reusable material. Salvage value of wire and other non-reusable material shall be a part of the bid price.]

3.5 CONCRETE WORK:

- A. Concrete for work under this [Division] [Section] shall be as specified [elsewhere.] [in [Division] [Section] []].]
- B. Reinforcement of concrete shall be as specified [elsewhere.] [in [Division] [Section] []].]
- C. Concrete involving a serving Utility's equipment or systems shall conform to the requirements of the Utility.
- D. Unless otherwise indicated, concrete shall be [2000] [2500] [3000] psi with maximum of 1" aggregate conforming to ASTM C-33, and reinforcing steel shall conform to ASTM A615.

3.6 RESTORATION OF SURFACES:

- A. Unpaved surfaces disturbed during the installation of ducts or electrical structures shall be restored to specified elevation and condition. Sod or topsoil shall be preserved carefully and replaced after the backfilling is completed. All damaged irrigation lines, sprinkler heads or controller wiring shall be replaced.
- B. The Contractor shall patch pavement, sidewalks, curbs and gutters where existing surfaces are removed or disturbed. Where necessary to cut, pavement edges shall be sawn.
- C. Concrete work shall be as specified [elsewhere]. [in Division] [Section] [].
- D. [Portland cement concrete pavement, sidewalks, curbs and gutters, shall be repaired using 3000 psi concrete. Pavement thickness shall match existing thickness but shall be at least 6". Sidewalk thickness and curb and gutter cross-sections shall match the existing.] [Restoration of public streets, curbs, sidewalks, etc. shall be per [City] [County] of [] Standards.]
- E. [Base Course: Aggregate base course shall have a maximum aggregate size of 1-1/2" and shall be uniformly graded. Prime base course with MC-70 prior to paving. Base course shall be at least 6" thick.]
- F. [Asphalt Concrete: Asphalt concrete shall be hot plant mixed and hot laid. Maximum aggregate size shall be 1/2" and asphalt cement shall be AR-4000. Thickness of asphalt concrete shall be at least 2".]

END OF SECTION

SECTION 16600 LIGHTING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS:

- A. Provide U.L. listed and labeled lighting fixtures complete with lamps at light outlets indicated on the drawings. Each fixture shall bear the U.L. Label, and shall comply with Code Requirements. Exterior fixtures shall be U.L. approved for damp locations in soffits and for wet locations elsewhere, and shall be so labeled.
- B. Design (including the frames) of recessed fixtures shall be compatible with the ceiling construction. Verify the type of ceiling and suspension method prior to ordering fixtures. Owner's representative's favorable review of the shop drawings for both the ceiling system and the lighting fixtures, with "No Exception Taken" or "Approved" on the Owner's representative's stamp, will not relieve the Contractor of the ceiling/lighting fixture compatibility requirement.
- C. Fixtures are listed and described in the Fixture Schedule and in the following paragraphs. Fixture catalog numbers are to be used as a guide only and shall be understood to be followed by the words "except as modified by the total fixture description both text and pictorial". Provide accessories, features and adaptations necessary to meet the requirements of the description.
- D. If the fixture designation is omitted from a light outlet, assume a fixture of the type used in similar areas in preparing the Bid. Confirm type with Owner's representative prior to ordering.
- E. Spare Parts: Provide the following spare parts to the Owner upon the completion of the project.
 - 1. Twelve (12) of each size and type lamp used.
 - 2. Two (2) of each type of luminaire lens used.
- F. Cleaning: After construction of total project is completed:
 - 1. Remove all non-essential labels and other markings.
 - 2. Wash dirty luminaires inside and out with nonabrasive mild soap or cleaner.
 - 3. Clean luminaire plastic lenses with antistatic cleaners only.
 - 4. Touch up all painted surfaces of luminaires and poles with matching paint supplied by manufacturer.

1.2 SUBMITTALS:

- A. Material List including reflector type and each type of lamp and ballast.
- B. Catalog cuts for each fixture including complete photometric data in IES format.
- C. Electronic ballast warranty.
- D. Shop drawings for custom fixtures, modifications or installations.
- E. Submit also catalog cuts for photocell, occupancy sensors, dimming components, time clock and lighting contactors.

- F. Where applicable, verify field dimensions and include them on shop drawings showing exact locations of lamp holders, lamp shapes and lengths.

1.3 ACCEPTABLE MANUFACTURERS:

- A. Electromagnetic Ballasts Advance, Valmont Electric, Jefferson, Universal, Sola
- B. Electronic Ballasts Magnetek-Universal, EBT-Advance, Motorola
- C. Lamps (Metal Halide only) General Electric, N.A. Phillips, Osram/Sylvania, Venture Lighting

1.4 LAMP REPLACEMENT:

- A. Replace lamps which burn out after Owner's use or acceptance of the project (or of an area in the case of beneficial occupancy).
 - 1. Lamps (except incandescent) which burn out within 120 days.
 - 2. Incandescent lamps which burn out after usage which is less than 80% of rated life.

PART 2 - PRODUCTS

2.1 FINISH:

- A. Treat surface mounted fixtures and exposed trim of recessed fixtures with a rust-inhabitant process. This process shall be Bonderlite or Oakite Cryscoat or equal zinc phosphate bonding process. Refer to paint, finishes and colors Subsection.

2.2 OPTICAL SYSTEMS:

- A. Lighting fixtures for use with HPS lamps shall have the optical system specifically designed for a clear HPS lamp of the wattage indicated.

2.3 BALLAST WIRING:

- A. Where multiple level switching of fluorescent fixtures is indicated on the drawings, wire ballasts for symmetrical grouping of lamps. For example in three lamp tandem fixtures, two inner and four outer lamps shall be switch controlled.

2.4 EMERGENCY/EGRESS FIXTURES:

- A. Exit Sign Fixtures:
 - 1. Emergency exit sign fixtures with illumination by LED's (Light Emitting Diodes), providing even illumination of letters through an optical diffuser to meet or exceed requirements of NFPA Life Safety Code 101 UL-924, and the OSHA code. The power supply shall be dual input 120/277V 60 Hz. All components shall be solid state, with surge protection and short circuit protection and each LED shall be individually driven such that failure of one will not affect another.

B. Self-Contained Emergency Lighting Unit:

1. Manufacturer:
 - a. Dual Lite
 - b. Lithonia
2. Provide compact, wall mounted emergency lighting unit containing the following:
 - a. 6 or 12 volt nickel cadmium battery capable of supplying 50 watts for a period of at least 3 hours, with guaranteed life of at least 5 years.
 - b. FULLY DISCHARGED to FULLY CHARGED period of 12 hours.
 - c. Two sealed beam 25 watt, fully adjustable lamps mounted on unit.
 - d. Relay automatically energizing lights upon loss of 120/277 volt, 60 Hz power.
 - e. Toggle switch in each lamp circuit so that each lamp may be turned off individually.
 - f. Time delay relay to keep units energized for 10 minutes after normal lighting is restored.
 - g. Circuitry will include low voltage battery disconnect, and brownout protection.
 - h. Each unit shall have diagnostic circuitry which shall constantly monitor the charger performance and battery voltage.
 - i. Each unit shall be programmed to exercise the battery and check emergency operation by automatically performing a 5 minute discharge/diagnostic test every 28 days and a 30 minute discharge/diagnostic cycle every 6 months.

2.5 BALLASTS:

- A. Fluorescent fixture electromagnetic ballasts shall be high power factor, low wattage (86 watts maximum for two 40 watt standard rapid start (RS) lamps when tested in accordance with ANSI C82.2 methods), and C.B.M. approved and shall be the recycling thermal protected type. Ballast for compact fluorescent lamps shall be A sound rated and high power factor. Replace all noisy ballasts. Ballasts installed outdoors shall be low temperature rated.
- B. Provide electronic ballasts in all fluorescent fixtures for which they are available unless otherwise noted. Electronic ballasts shall be high power factor, sound rated 'A', contain no PCB and be listed by U.L. Ballasts shall have fewer than 32 components and operate at 20 to 35 KHZ. Ballast shall be fully potted and within steel case, operating temperature of ballasts shall not exceed 80 C at any point on the case. Ballast shall be surge and transient protected to 6000 volts and shall comply with FCC or NEMA limits as to EMI or RFI and not interfere with the operation of other electrical equipment. Ballast shall carry a minimum three year unconditional warranty for labor and materials. Ballasts shall be approved by the local utility company for energy rebates.

- C. Emergency battery pack ballasts for fluorescent lighting fixtures shall consist of an automatic power failure device, single pole test switch, and fully automatic solid-state charge and indicator light in a self-contained power pack furnished by the fixture manufacturer as an integral part of the fixture. Electronic circuitry shall be self-testing in design and automatically test the unit every 30 days for 30 seconds, and initiate a 90 minute discharge test once a year. An embedded microcontroller will continually monitor battery charging current and voltage. Audible alarm and a light-emitting diode will be provided to indicate test results and status conditions. Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be no maintenance nickel cadmium type with capacity to supply power to one or two lamps for each fixture in emergency mode for 90 minutes minimum. Unit shall be capable of operating a dead fluorescent lamp.
- D. Fluorescent [and] [HID ballasts] [and emergency battery pack ballasts] shall be guaranteed for [2] [3] [5] years.
- E. High-Intensity-Discharge-Lamp Ballasts: Provide HID lamp ballasts, including remote ballasts as necessary, externally fused, capable of operating lamp types with rating indicated and of starting lamps between 0 degrees F and 105 degrees F; constant wattage auto-transformer type, high power factor, core and coil assembly encapsulated in non-melt resin; install capacitor outside ballast encapsulation for easy field replacement; enclose assembly in drawn aluminum alloy housing(s) with necessary wiring compartments and provisions for electrical connections and devices; and mount assembly with necessary hardware and vibration dampers. Encase ballasts for outdoor use in weathertight enclosures and provide proper outdoor type wiring devices.
 - 1. Metal Halide:
 - a. 120 Volt Applications:
 - 1) High power factor, normal ambient, constant wattage ballasts for various voltages and wattages as shown.
 - 2) Ballasts shall limit lamp wattage variation to 5% for line voltage of 10%.
 - 3) Line current during starting and lamp warm up time shall not exceed normal operating current.
 - b. 277 Volt Applications:
 - 1) Provide linear reactor pulse-start ballasts for wattages as shown.
 - 2. High Pressure Sodium:
 - a. Provide reactor (high power factor) type for operation at voltage shown.
 - 3. Low Pressure Sodium:
 - a. High power factor, normal ambient, constant wattage.
 - b. Ballasts shall limit lamp wattage variation to 5% for line voltage change of 10%.
 - c. Line current during starting and lamp warm up time shall not exceed normal operation current.

F. Dimming ballasts for fluorescent lamps shall be as listed below unless specifically indicated otherwise in the drawings.

1. Dimming range 100% - 1% - Lutron Hi-Lume
2. Dimming range 100% - 5% - Lutron Hi-Lume or Advance Mark X.
3. Dimming range 100% - 10% - Lutron ECO-10.

2.6 LAMPS:

A. Provide lamps as listed below unless specifically indicated otherwise in the Lighting Fixture Schedule.

B. Incandescent General Service Lamps: Inside frosted, standard life, 130V.

C. Each type of lamp by only one manufacturer to maintain color consistency.

D. Provide lamps and ballasts that are a compatible system.

E. Fluorescent Lamps:

1. Compact fluorescent; 4100K degree color for interior locations and 2700K degree color for exterior.
2. 40 watt "Biax"; [Standard cool white] [Standard warm white] [lite white] [3500 K] [4100 K].
3. Rapid-start lamps; [Standard cool white] [Standard warm white] [lite white] [3500 K] [4100 K].
4. Lamps designated for dimming shall be seasoned (run at full output) for 100 hours prior to dimming.
5. Provide reduced Mercury lamps, such as Philips Alto and GE's Ecolux, in available sizes and wattages. The lamps should pass the EPA's Toxicity Characteristic Leaching Procedure (TCLP) test.

F. High Intensity Discharge (HID) Lamps:

1. High pressure sodium lamps shall be color improved type GE Delux Lucalox, or equal.
2. Metal halide light fixtures that utilize a horizontal lamp configuration shall be provided with a [clear] [coated] lamp rated for horizontal operation.
3. Provide pulse start technology metal halide lamps.
4. Low pressure sodium lamps shall have the following characteristics:
 - a. Non-metallic bayonet base for safe relamping, sodium retaining reservoirs, U-bend insulation to control lamp wattage rise, arc tube support system to protect lamps arc tube from shock and vibration, uniform indium oxide heat reflecting coating, barium getter, triple coil electrode and fuse coil in lamp base.

- G. Fixtures shown as relocated shall be cleaned, repaired and relamped with new lamps matching existing lamps in the same room or as otherwise designated or as indicated on drawings.

2.7 LENSES:

A. Light transmitting plastics:

- 1. All plastic shall be 100% virgin acrylic. Pattern #12 lenses shall be minimum .125-inch thick overall with .08-in. prism depth.

B. Glass:

- 1. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass, Corning #7740 or equal. For fixtures directly exposed to the elements and aimed above the horizontal, use Corning Vycor glass or equal.

2.8 SITE LIGHTING LUMINAIRES:

- A. Luminaires shall be mounted on poles as shown on the drawings and shall be of the type and manufacturers shown in the schedule [, or approved equal]. Luminaires shall be mounted [flat and level, with no tilt or cant] [or tilted to the exact angle indicated.] Luminaires of one type shall be of one manufacturer and of identical finish and appearance.
- B. Provide all lamps, ballasts, and mounting hardware required for a complete installation. Mounting hardware shall be completely compatible with, and designed for use with, the proposed pole.
- C. [Finish shall be electrostatically applied baked-on [black] [] enamel over a prime coat. Finish shall match poles with no detectable difference under normal viewing conditions. Any minor damages to paint after delivery shall be touched up with paint provided by the manufacturer. Any major paint damage shall be repaired in the factory by the original process.]
- D. [Provide birdspikes type L53 Nixalite Bird Control or equal (no known equal). Attach to top of luminaires using epoxy adhesive as recommended by birdspike manufacturer.]
- E. Submit a computer generated layout of the site showing the illumination levels in footcandles that will result using all proposed fixtures, luminaires, and poles.
- F. Submit catalog cuts and data sheets for each type and wattage proposed. Submittals shall be bound with the pole submittals and shall include complete information on all lamps, ballasts, lenses, and mounting hardware. [Submit a production run sample of a typical luminaire proposed. Sample will be returned.]

2.9 LIGHTING POLES:

- A. Poles shall be of the type configuration and height shown on the drawings and shall be [as shown on drawings] [provided by the luminaire manufacturer] [Centricon,] [or] [Union Metal,] [or] [] [,or equal].

- B. Poles 10' or longer shall be designed to withstand when installed a wind load of [100] [80] [] MPH with a gust factor of [1.3] []. Submittal shall include a statement or other evidence of compliance.
- C. Luminaire mounting provisions shall be designed for complete compatibility with the luminaire to be installed.
- D. Poles shall be one piece [round] [square], [tapered] [straight], [steel] [aluminum] with anchor bases welded to the shaft inside and out. Manufacturer shall furnish galvanized steel anchor bolts having an "L" bend. Bolts shall be complete with washers and hex nuts for leveling. [Provide a base cover. Hardware up to 8' from the base shall be tamper proof.] A handhole or access plate shall be located near the base and shall be reinforced as necessary.
- E. Poles shall be [natural finish.] [galvanized.] [prime painted only.] [painted to match luminaires as closely as possible if luminaires are anodized and shall be painted with the same color exactly if the luminaires are painted. Prime poles before painting and touch up as necessary after installation. Paint shall be 2 coats of exterior enamel either shop applied by the manufacturer or furnished by the manufacturer for field application. Touch up paint shall be furnished by the manufacturer for field application.]
- F. [Finish shall be electrostatically applied baked-on black enamel prime coat. Finish shall match luminaires with no detectable difference under normal viewing conditions. Any minor damages to paint after delivery shall be touched up with paint provided by the manufacturer. Any major paint damage shall be repaired in the factory by the original process.]
- G. Concrete poles shall be round, tapered, centrifugally cast in steel molds and prestressed. Concrete shall contain natural aggregate conforming to ASTM C-33 and shall have a minimum 28 day compression strength of 7000 PSI. [A pure mineral oxide admixture shall be used to color the concrete] [dark brown.] []. Surface shall be blasted to a uniform finish [and a clear acrylic sealer applied].
- H. Concrete foundations shall be round, of the size shown on the drawings. Concrete shall [be cast at 3000 psi with reinforcement steel conforming to ASTM A615. Concrete shall conform to ASTM C-33, and shall have a troweled finish with 1" chamfered edge.] [Conform to [the paragraph "CONCRETE WORK".] [Section .]
- I. Poles shall be aligned vertically true with luminaires installed and while no wind is blowing. Base nuts shall be tightened in this position. Bolts in foundations shall be installed in such a way that luminaires on the poles will be facing in the direction shown on the drawings. Luminaires shall be bolted to the poles and adjusted so that the luminaires lens will be perfectly horizontal or tilted to the exact angle specified.
- J. Take all necessary precautions against damaging existing and new surfaces, structures and other work on the site during handling and erection of poles. Provide barriers to keep others at a safe distance during excavation, erection and assembly.
- K. Provide outdoor ground mounted poles or floodlight units with concrete bases, either as detailed or, if not detailed, as recommended by the manufacturer. Fixtures mounted directly on conduit as supports, such as floodlights on grade, shall have a minimum 8-in. cube of concrete at or below grade to anchor fixture.
- L. Provide non-metallic bolt cover in finish to match pole.

2.10 LIGHTING CONTROL SYSTEM:

A. Motion Sensing:

1. Motion sensing lighting control system shall be installed where shown to switch lighting fixtures ON when a room or area is entered and OFF after a preset time delay after sensing no motion or occupancy.
2. System shall consist of motion sensor units, switchpacks, wiring, and miscellaneous electrical hardware. Ceiling mounted sensing and switchpack units shall be manufactured by Unenco, Sensorswitch, Watt-Stopper [or approved equal]. Wall switch type unit shall be provided by Unenco, Sensorswitch, Watt-Stopper, [or approved equal].
3. Sensor Units shall be:
 - a. Wall Switch Type: Totally self contained passive infrared [120] [277] VAC 60 Hz, as required. Coverage approximately 300 SF.
 - b. Bi-Level Wall Switch Type: Totally self-contained passive infrared [120] [277] VAC 60 Hz, as required. Coverage approximately 1,000 SF. switching two [2] circuits with a combined capacity of 1,000 watts ballast, 600 watts incandescent at 120 volts or 1800 watts ballast at 277 volts.
 - c. One-Way Room Type: 15 VDC powered from switchpack. Passive infrared coverage approximately 900 SF.
 - d. Two-Way Room Type: 15 VDC powered from switchpack. Passive infrared coverage approximately 2100 SF.
 - e. Corridor type: 15 VDC powered from switchpack. Infrared corridor coverage approximately 14' X 90'.
 - f. 360 Ultrasonic Type: [120] [277] VAC 60 Hz, self-contained ultrasonic unit with coverage of approximately 800 SF.
 - g. 360 Dual-Technology Type: [120] [277] VAC 60 Hz, utilizes both passive infrared and ultrasonic technology, coverage 1200-2500 SF, field adjustable to set best combination technology to suit application.
4. Switchpack shall combine a Class 2 transformer and heavy duty 20 amp power relay in a single housing. Power input 120 or 277 VAC. Mount in 4" junction box with line connections inside. Output 15 VDC 200 mA, Class 2. Model #13-011.
5. Units shall detect motion by means of passive infrared, ultrasonic sound, which shall be inaudible to occupants, or dual technology. Finish shall be off-white, housing shall be injection molded thermoplastic of an attractive design. Mount as shown by means of manufacturer supplied mounting hardware. Adapter plates shall be used where mounting on fixture rings or hard ceiling. Locate sensor in space as recommended by manufacturer for optimum performance and shall be adjusted to suit individual room configuration and obstructions. Do not mount in path of strong air movement such as near supply or return grills or diffusers. Time delay and sensitivity controls shall be integral with the units and accessible from the room. Sensitivity shall be adjustable and delay shall be adjustable from 30 seconds to 15 minutes. Set as directed by [].

B. Photocells:

1. Photocells shall include the following features:
 - a. Automatic ON/OFF switching photo control.
 - b. Completely self contained in die cast aluminum housing not affected by moisture, vibration, or temperature changes.
 - c. ON at dusk and OFF at dawn.
 - d. Time delay feature to prevent false switching.
 - e. Field adjustable to control operating levels.
 - f. Wet location listed by UL.
 - g. Locate photocell facing north.
 - h. Acceptable Manufacturers:
 - 1) Tork
 - 2) Paragon

C. Time Clock:

1. Provide 7-day, four channel electronic time control. Each of the four channels shall be independently programmable for each day of the week, plus an eighth day holiday program. Capable of time-of-day scheduling with maintained or momentary contact. Control shall have astro-dial feature and can be programmed for automatic daylight savings time changeover.

D. Lighting Contactors:

1. Provide contactors 100% rated for all types of ballasts and tungsten lighting, electrically operated, mechanically held with coil clearing contacts, rated 600 volts, 20 amperes per pole.

2.11 LIGHTING CONTROL SYSTEM:

A. Programmable:

1. Quality Assurance:
 - a. ETL Approvals: The control panels shall be tested and listed under the UL 916 Energy Management Equipment and UL 508 standards by a nationally recognized testing laboratory.
 - b. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
 - c. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.

- d. Components Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.
 - e. Manufacturer: Manufacturer shall have a minimum of five years experience in control systems.
- B. Product shall be ILC to match the existing ILC Enercon system installed in the Outlet Center.
- 1. Compatibility:
 - a. The lighting control system shall be an extension of the existing ILC Enercon RSX 1500 system presently in use at the existing Outlet Center.
 - b. All components shall be compatible with and communicate with the existing host system.
 - 2. Submittals:
 - a. Product Data: Submit manufacturer's data on lighting control and components.
 - b. Shop Drawings: Submit drawings of lighting control system and accessories including, but not necessarily limited to, the low voltage relay panels, power wiring and switch inputs.
 - 1) Riser Diagram/System Diagram
 - 2) Switch Input Wiring
- C. Materials and Components:
- 1. The lighting control system shall consist of low voltage relay control panels with 16 programmable switch inputs, and 16 programmable switch outputs.
 - 2. Each low voltage lighting control panel shall be micro-processor controlled.
 - 3. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, a Warn Off to warn occupants of an impending OFF, preset control and local control.
 - 4. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending OFF command. The Warn Off command will allow 10 extra minutes for the occupants to override their lights or exit the premises.
 - 5. Control panels shall permit lighting to be override ON for after-hours use or cleaning. These overrides shall be hard-wired inputs or voice-guided touch-tone telephone control.
 - 6. Control panel enclosures shall be provided with 32 relays.
 - 7. Programming the control system shall be through the local integral keypad or through a PC running the Supervisor software.

D. Hardware Features:

1. Operator Interface: The interface for programming the control panels shall reside in firmware resident within the control panel. The programming shall consist of a circuit board mounted keypad capable of programming all switch inputs and relay outputs to switch assignments. Systems that utilize blocking diode technology for relay assignment shall not be acceptable.

E. The integral keypad shall provide access to all programming features. The keypad shall permit the user to manually command any or all relays individually.

F. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted.

1. Contact Inputs: The control system shall allow dry contacts for override purposes. Momentary contacts shall be supported as three-wire (Momentary). Inputs shall be dry contacts (24 VDC @ 12 mA, internally supplied to the inputs). An input shall be software linkable to any number of relays for override control. The control system shall accept 32 dry contact switch inputs.

G. Software linking of inputs between panels shall eliminate the use of blocking diodes. Up to five control panels may share switch inputs.

1. Time-Of-Day (TOD) Control: The programmable low voltage lighting control panels shall support TOD scheduling. Each controller shall provide 32 TOD schedules for relay control. Software shall permit the user to create ONs and OFFs, or ONs only, or OFFs only. The control panels shall provide default times and group linking for rapid programming. The controller shall provide 12 programs for Monday-Friday, seven programs for Saturday, seven programs for Sunday and six programs for holidays.

2. Preset Control: Each input shall provide the ability to perform presets from switch inputs. Relays commanded from a switch input shall provide various switching patterns based on programming. One input may command certain relays ON and other relays OFF.

3. Warn Off: The warn Off option shall provide a blink and a 10-minute delay OFF timer to the selected output when the linked output proceeds to the OFF state. This option occurs with the switch inputs, telephone override control and the Time-Of-Day schedules.

4. Relay Type: The system shall utilize control relays that are rated to at least 20 amps at 277 VAC. A limited 10-year warranty shall be provided on the individual relays.

5. Modular Design: The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick-release spring pins that shall permit an entire change out of the processor and input board in less than one minute.

H. All connections for the switch inputs shall incorporate modular connectors. The relay board shall be modular and designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.

1. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of proper operation or, in case of failure, and guide the individual in rapid troubleshooting of the system.

- I. The control panels shall employ Light Emitting Diodes (LEDs) that visibly indicate:
 - POWER
 - SYSTEM OK
 - ON/OFF STATUS OF EACH RELAY
 - SYSTEM CLOCK
 - PROGRAMMING CONFIRMATION (TOD, HOLIDAY, ON/OFF AND PRESET)
- J. Control systems that do not provide visual self-help diagnostics shall not be acceptable.
 - 1. Battery Back-Up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 10 years. The power interrupt protection circuit shall be entirely maintenance free.
 - 2. Multi-tapped Transformer: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 and 277 VAC shall be available with each standard control panel.
 - 3. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose ON/OFF status and relay number.
 - 4. Service Override: The control panel shall provide a three-position service override for the entire panel. The service override shall not be accessible from the exterior.
 - 5. Lockable Enclosure: Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.
 - 6. Telephone Overrides (TIM): The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The TIM unit shall allow modern communications and touch-tone overrides from any touch-tone phone. The control system shall permit one TIM per lighting control panel.
- K. Touch-tone interface shall permit the control panel to override the preassigned control points ON/OFF accordingly. All users interface shall be through the 12 touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice-guided override instruction are not acceptable.
- L. The TIM shall provide individual control passwords. Each password shall allow a preset group control for after-hour.
 - 1. Modem: The modem shall utilize the Hayes compatibility standard and enable modem access as defined by the Bell 212A and CCITT V.22 protocol standards.
 - 2. PC-Based Interface (Supervisor): The lighting control panels shall be programmable through a PC. The PC connection shall be a RS-232 direct connection to the lighting control panel at 9600 baud. A software package shall be provided to allow individual panel programming to be executed locally or remotely through a 2400 baud modem. Individual files shall be programmable in either an on-or off-line fashion.

M. The software package shall provide a vehicle to upload and download data files. The package shall provide backup and restoration of all programmed data from magnetic media for added backup protection. The software functions shall be enhanced by color pop-up menus for clarity of use. Specific programming printouts shall be available for user documentation.

N. Equipment Installation Documentation:

1. Installation: The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits and override wiring.
2. Documentation: The contractor shall provide accurate "as built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.
3. Operation and Service Manuals: The factory shall supply all operation and service manuals as related to the design of the control system.

O. Product Support and Services:

1. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment. The factory shall maintain toll-free numbers for technical support for their customers.

P. System Delivery and Acceptance:

1. Delivery: Delivery of the control system shall be 4 weeks of the "notice to proceed". The contractor is responsible for complete installation of the system according to strict factory standards and requirements. The following items shall be included requirements.
 - a. All system equipment shall operate in accordance with specification and industrial standard procedures.
 - b. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
 - c. Demonstration of program integrity during normal operation and pursuant to a power outage.
 - d. Contractor shall provide a minimum of two hours training on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the Owner's representative.

Q. Warranty:

1. Warranty: Manufacturer shall supply a one-year warranty on all hardware and software. A limited 10-year warranty shall be provided on the individual relays.

2.12 COLD CATHODE LIGHTING:

- A. The Electrical Contractor shall furnish and install the complete cold cathode lighting installation as described in the architectural details. They shall be manufactured by National Cathode Corp., Architectural Cathode, or approved equal.

- B. Lamps shall be cold cathode, mounted in a right-angle electrode configuration as manufactured by National Cathode Corporation, Architectural Cathode or approved equal. Lamps shall produce 650 lumens per foot (tri-phosphor warm white) when operating at 200 ma. and shall not depreciate more than 20% after 10,000 hours of operation.
- C. Lamps shall be made from nominal 1" diameter lead glass tri-phosphor coated and baked, with heavy duty coated electrodes and shall be fabricated to the shapes and sizes allowed for on the architectural details. They shall be silicone-coated, shall have adjustable snap-on lamp reflectors, and must be filled with argon, neon, and krypton for cold weather applications. They shall be as manufactured by National Cathode Corp., Architectural Cathode, or approved equal.
- D. Lampholders shall be right-angle type, approximately 94" o.c. maximum, for continuous line of sight, by National Cathode Corp., Architectural Cathode, or approved equal. They shall be U.L. listed, white glazed porcelain with spring bronze clip contacts for proper electrical contact and lamp support.
- E. Ballasts required for the cold cathode lamps shall be U.L. listed, HPF, 115 volt, 60 cycle, secondary 200 ma. as manufactured by National Cathode Corp., Architectural Cathode, or approved equal.
- F. High Power Factor Transformers are to be 115 volt, 60 cycle, secondary 120 ma. operating current, mid-point grounded with voltage as required by lamp footage and no dimming. Normal power factor transformers are to be 115 volt, 60 cycle, secondary 96 ma. operating current, no mid-point ground with voltage as required by lamp for dimming by lamp footage.
- G. Transformer and Ballasts are to be located in accessible and ventilated areas (100 degrees F. maximum ambient temperature) with air circulation on all sides to dissipate about 300 watts each.
- H. Install transformers and ballasts as close to lamps as possible in order to keep secondary feeds as short as possible. Wiring compartment shall be accessible.
- I. Installation of lamps, lampholders, secondary feeds, and ballasts shall be in strict accordance with the intent of the contract drawings and approved shop drawings of the cold cathode manufacturer. The contractor shall install the lampholders so that all lamps make secure electrical contact in the lampholders.
- J. Circuit breakers and switches controlling the circuits feeding the cold cathode ballasts shall be capable of being locked in the open position. All cold cathode fixtures shall be supplied electrically through distribution transformers dedicated to lighting only, in order to prevent injection of "noise" into the electrical system which may affect other systems.
- K. Shop drawings shall include scale plans and details showing the method of installation of lampholders, lamps, reflectors, ballasts, and secondary feeds, as well as a complete bill of materials. The shop drawings shall show the exact locations of the lampholders and lamp shapes and lengths, and four copies shall be supplied, incorporated in the maintenance manuals.
- L. Manufacturer: The following information shall be provided by the Contractor within 60 days of signing of the contract: name of manufacturer, and list of previous jobs using nominal 1" dia. lamps operating at 200 ma.

2.13 NEON:

- A. The Contractor shall furnish and install the complete neon lighting installation as described in the architectural details. It shall be manufactured by Neon by Sklar, Inc., or approved equal.
- B. Lamps shall be _____mm diameter glass tubing. They shall provide a continuous line of light. Lamp output and glass tubing diameter shall be in accordance with contract drawings. Maintained lamp lumen output Lamps shall produce _____ lumens per foot and shall not depreciate more than 20% after 10,000 hours of operation. Lamp color to be selected by Architect based on samples provided. Process lamps with mechanical pump and accurate gauges and meters for measuring and controlling pressures, temperatures, carrier gas and mercury. Silicon coat and age completed lamps for 15 hours. Reject lamps showing darkening, stains, discolorations, spiralling or sputtering.
- C. Lampholders shall be electrodes approximately 94" on center maximum, U.L. listed for 7500 volts minimum. All lamp terminations to be made in #200 Pyrex sockets enclosed in metal. These shall give good electrical contact and properly support the lamps. Provide additional lamp supports for curved or bent lamps.
- D. Transformer size shall not exceed 9,000 volts, 30 ma. Transformer shall be located as symmetrically as possible in relation to the lamp run. Provide self-contained, UL listed transformers in 16 gauge steel housings with secondary and primary wiring compartments, and a disconnect switch which will automatically disconnect the primary switch when the wiring compartment cover is removed. The wiring compartments must be accessible. Install transformers only in accessible and ventilated areas (100 F. maximum ambient temperature) with air circulation on all sides to dissipate about 300 Watts each.
- E. Wiring shall be UL listed secondary feeds of GT0-15 cable with run to transformer not to exceed 35'-0". All feeds shall be within aluminum flexible conduit terminating within metal enclosure at Pyrex socket. Locate transformer as close to lamps as possible to avoid long secondary feeds in metallic conduit and corona discharge, which can lead to overloading, transformer failure, shortened lamp life, and audible noise.
- F. Shop drawings to be complete submissions for approval and maintenance. These shall include wiring diagram, scale plans and details showing the method of installation of lampholders, lamps, reflectors, transformers and secondary feeds as well as complete bill of materials. Verify field dimensions and include them on shop drawings showing exact locations of lampholders, and lamp shapes and lengths. Provide sepia copies of approved shop drawings for Owner's use in maintenance and lamp replacement.
- G. Installation of lamps, lampholders, secondary feeds and transformers shall be in strict accordance with the intent of the contract drawings and approved shop drawings of the neon manufacturer. The Contractor shall install the lampholders so that all lamps make secure electrical contact in the lampholders. Apply paint finish prior to lamp installation within architectural coves.
- H. Circuit breakers controlling the circuits feeding the neon transformers shall be capable of being locked in the open position.
- I. Manufacturer: The following information shall be provided by the Contractor within 60 days of signing of the contract: name of manufacturer and list of previous jobs using neon.

2.14 FIBER OPTIC LIGHT FIXTURES

- A. General Constructions and Materials: Illuminators and fibers shall be of one manufacturer to insure compatibility.
- B. Illuminators: Shall meet all conditions previously listed for their respective sources.
- C. Where fans are used for cooling, they shall be low noise and quiet running.
- D. Illuminators shall have ultraviolet and infrared absorbing filters to prevent gradation of the fiber.
- E. Metal Halide Illuminators shall have a safety cut out switch to prevent operation when the illuminator is opened for servicing.
- F. Provide suitable thermal cut out protection.
- G. All fibers shall be cut and installed per manufacturers specifications.
- H. Equipment shall be listed for wet location if applicable.

2.15 DIMMING SWITCHES:

- A. Switches for dimming lighting shall be Lutron "Nova" [] series, [or equal].
- B. Units shall be solid state, voltage stabilized, with a sliding intensity control and a positive, silent, on-off position [at the lower end of travel]. The front shall have a flat faceplate over a finned heatsink. Faceplate finish shall be white except where otherwise indicated. Heatsink, where required, shall be natural aluminum.
- C. Units shall be solid state [electronic] with a sliding or rotating intensity control and an on-off position at the low end of travel. [The front shall have a flat metallic faceplate with a finned heatsink] [The front shall be trimmed with a plate as specified under "DEVICE AND BOX COVER PLATES"].
- D. Dimmers shall be rated for incandescent, fluorescent, or low voltage [magnetic] [electronic] use, as required for the load to be controlled.
- E. Wattage rating of unit shall exceed the load controlled unless a specific rating is shown on the drawings, in which case the rating shown shall be installed.
- F. Dimmers shall be [individually] [gang] mounted [with all fins intact.] Provide separate neutrals back to the lighting panel and from the dimmer(s) to each load controlled.

2.16 DIMMING SYSTEM:

- A. Dimmer Panel: Dimmer Panel shall be a Lutron #DP-4 surface wall mounted, with (3) incandescent dimming modules, input 20A, 1P circuit breakers as shown on drawings, main feeder lug connection, NEMA Grade 14 gauge steel cabinet, and ventilated cabinet for natural convection cooling. Dimmer panel shall be bussed and rated for 120V operation. Panel shall have space available for addition of (1) future dimming module.

B. Dimming Module:

1. Dimming module shall be a Lutron #DM-2000/3 rated at 120 volts, 60 Hz, 6000 watts maximum connected capacity.
2. Dimming modules shall consist of (3) built-in 2000 watt dimmers. Each dimmer can independently control lighting zones up to 2000 watts or jointly control zones with 4000 or 6000 watts of load.
3. Each dimmer shall be provided with (2) 20A, 1P circuit breakers as shown on drawings.
4. Modules shall have tungsten surge protection, smooth continuous square LAW dimming, and filtering networks which eliminate audible lamp filament vibration and suppress radio frequency and electro-magnetic interference.

C. Dimming Master Control:

1. The dimmer master control panel shall be a 4 scene, 5 zone with 4 pre-set pushbuttons and system off switch, Lutron "Aurora" #VA-5-4. Panel front shall be brushed aluminum.
2. Each of the 4 scenes may be called up by the touch of a pre-set button. Fade rate between scenes shall be adjustable from 1 - 60 seconds.
3. Master control panel shall have illuminated slide potentiometers to provide visual indication of lighting level in each of the four pre-set scenes. System shall have power failure memory.
4. Manufacturer shall provide an initial set-up and demonstration session with [] at time designated by [District.] [Architect] []. Once scenes have been set, manufacturer shall label pre-set selection buttons for ease of operation by school faculty.
5. Dimming system's panels, dimmers, devices and components shall be of one manufacturer. System shall utilize a low voltage Class 2, 24 volt D.C. wiring system as shown on drawings.

D. Remote Dimming Control Devices:

1. Remote dimming control device in Multi-Purpose Room shall be Lutron "Aurora" #VCA-6-SM. Control device shall have (6) calibrated manual slide controls, each providing square LAW dimming. Five of the slide controls shall control independent lighting color zones. The sixth slide control shall be a "master scene" control. Remote control device shall have (4) touch buttons for selection of (4) preset scenes, with electronic fade between scenes. A fifth touch button shall turn system off.
2. Control device faceplate shall be machine fabricated of solid brushed aluminum with clear anodized finish with no visible screws on fasteners. Provide custom factory engraving above each slide control indicating each color controlled, as detailed on drawings.

PART 3 - EXECUTION

3.1 FIXTURE MOUNTING:

- A. Provide fixture supports. Design (including the frames) of recessed fixtures shall be compatible with the ceiling construction. Verify the type of ceiling and suspension method prior to ordering fixtures. Owner's representative favorable review of the shop drawings for both the ceiling system and the lighting fixtures, with "No Exception Taken" or "Approved" on the Owner's representative's stamp, will not relieve the Contractor of the ceiling/lighting fixture compatibility requirement.
- B. Mount pendant fixtures at the heights indicated on the drawings, unless otherwise directed by Owner's representative. Fixtures shall have approved earthquake resistant hangers if code required and have movable joints at ceiling and fixture when more than one stem is used per fixture. Support fixtures mounted on suspended ceilings directly from the structure above using a #9 wire. The runner shall not be used in the support linkage, but shall be bypassed with a suitable device.
- C. Two hanger wires shall be provided for each recessed fluorescent fixture. Locate at diagonal corners. Securely clip or bolt recessed fixtures to ceiling support system by a Code approved method.
- D. Attach surface fixtures mounted on accessible panel type suspended ceilings to a main runner with a positive clamping device made of minimum 14 gauge steel. Rotational spring catches will not be permitted. Attach a #9 suspension wire to the main runners within 6-in. of the location so that the fixture loads the runner (at least 2 wires per fixture). Mount fixtures which are on combustible ceilings on spacers as required by Code unless Code approved for mounting directly on ceiling.
- E. Rigidly align continuous rows of lighting fixtures for true in-line appearance.

3.2 FIXTURE LOCATIONS:

- A. Locate lighting fixtures in accordance with architectural reflected ceiling plans. If conflict exists with lighting plans obtain clarification from Owner's Representative prior to installation.
- B. Locate fixtures installed in Mechanical Equipment Rooms after ducts and piping are in place for maximum working space coverage. Connect with exposed conduit. Provide conduit with conduit fittings for boxes and offsets. Support fixtures from the structure independently of ducts or piping.
- C. In the areas with exposed beams and other structural elements, locate exit sign fixtures after these elements are in place for maximum sign visibility. Locate an accessible flush outlet with extension ring at or near the location where the sign is indicated on drawings. The exit sign locations will be fixed during a walk-thru by the Architect and Code enforcing authorities prior to the completion of the project. Extend the exit sign with exposed conduit provided with conduit fittings for boxes and offsets. Support fixtures from the structure independently of ducts or piping.

3.3 FIXTURE INSTALLATION:

- A. Provide outlet boxes for recessed fixtures in a manner approved by the Code. In non-accessible ceilings provide access to junction boxes, ballast, transformers, and battery packs through fixture apertures; no access panels in ceiling. Provide appropriately temperature rated insulation for branch wires to recessed fixtures.

- B. Coordinate with other work as appropriate to properly interface installation of lighting fixtures with other work. Verify location and spacing with architectural reflected ceiling plans. Notify Purchaser's Representative of field conditions at variance with plans and/or specifications before commencing installation.
- C. Install lighting fixtures securely, level, plumb, aligned, and in straight rows. Lighting fixtures must be installed so they do not shift during relamping or adjustment.
- D. Recessed Fixtures:
 - 1. Supports: Provide seismic clips and bracing per Code.
 - 2. Holes for Recessed Fixtures
 - a. Minimum-width fixture trims are specified for this project. Cut holes to follow fixture housing exactly so no gaps will be visible after trims are installed.
 - b. Round holes in acoustic tiles: Pre-cut holes in center of tiles, using adjustable-diameter cutter on slow-speed drill press.
 - 3. Install bottom of housing aligned with finished ceiling.
 - 4. Keep ceiling insulation at least 3" away from fixture.
 - 5. Install trims after painting of spaces. Install trims tightly, with no gaps or light leaks. For exterior fixtures provide seals and gasketing to prevent insect entry into the fixtures. If soffit recessed fixtures are not available with a sealed housing, provide effective gasketing for the lens and for the lens trim/soffit surface interface.
- E. Ceiling-Mounted and Pendant Fixtures:
 - 1. Supports: provide support for outlet boxes so fixtures can be installed securely, including seismic supports and restraints per Code.
 - a. Fixture weight less than 50 lb. at each suspension point: hang from strap or stud on outlet box.
 - b. Fixture weight over 50 lb. at each suspension point: hang directly from structure, either independent of outlet box or from approved fixture stud extending through outlet box to structure.
 - 2. Fixtures over 18" long or wide: provide additional supports at all corners.
- F. Wall-Mounted Fixtures:
 - 1. Mounting heights shown on drawings are measured from finished floor to centerline of outlet box or recessed housing, unless otherwise noted.
 - 2. Verify fixture weights and provide backing in wall as required.
 - 3. Wet locations: Install sealant between fixture and outlet box.
- G. Where 2' X 2' fixtures are in a room with 2' X 4' fixtures, the longitudinal axis of the lamps shall be oriented in the same direction for both sizes of fixtures.

H. Aiming and Adjustment:

1. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjusting is completed, locking setscrews, bolts and nuts shall be tightened securely.

3.4 UTILITY DESIGN INCENTIVE (REBATE) PROGRAM:

- A. Contractor is to provide the utility company representative with the itemized, paid proof of purchase/invoice for the purchase and installation of energy efficient equipment.
- B. To assist the utility in the verification by utility representative of both the purchase and installation of the energy efficient equipment, including providing the representative access to the Construction Project, at reasonable times, for verification of installation of the equipment.
- C. To provide the utility with a written request for payment of the Incentives calculated, when the Construction Project is completed and occupied.

END OF SECTION

SECTION 16800 UTILIZATION EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS:

A. Scope of Work:

- a. This Section describes electrical service to and connection of all equipment furnished and installed under other Divisions or by the Owner.
- b. Provide service and connections to all equipment shown on drawings or described herein including the "Not in Contract" (NIC) equipment which is to be furnished and installed by others. If NIC equipment shown or described is not installed prior to completion of construction, provide flexible conduit, boxes, receptacle, cords, plugs and cable pigtails as directed by the Owner for the future connection of the equipment. Refer to manufacturer's technical data if necessary.
- c. The electrical components of equipment, such as motors, motor starters which are integral with the equipment, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control equipment, and control wiring and conduit (regardless of voltage), are part of the work of other Divisions, unless specifically noted otherwise. Refer to drawings and specifications of the other Divisions for definition of the extent of work not described by Division 16 drawings and specifications but which is a part of the work of Division 16.
- d. Sections of these specifications which describe electrical service, rough-in and/or interface requirements include (but are not limited to) the following:

DIVISION 15 MECHANICAL

Refer to all sections of Division 15

B. Motor Protective Data Tabulation:

- a. Prepare a tabulation of motor data which shall include the following:
 1. Motor designation as indicated on plans.
 2. Motor data shown on the motor nameplate.
 3. Setting of motor short circuit protection.
 4. Motor starter size.
 5. Overload element ratings.
- b. Submit three copies of the tabulation for review and permanent record to be referred to in the event of failure of any motor either within or beyond expiration of the warranty period.

1.2 SUBMITTALS:

A. Motor Data Tabulation

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Provide the necessary power supply conduit and wiring to all equipment.
- B. Provide equipment disconnect switches as indicated on drawings and as required to conform to Code. Safety switches shall be horsepower rated when used with motors. Toggle type manual motor starters without overload protection may be used, within their ratings, switches for motor disconnects as shown on drawings.
- C. Verify ratings of fuses as indicated on drawings with the manufacturer of the equipment actually installed and provide fuses in conformance with the manufacturer's recommendations.
- D. Provide all rough-in work for equipment from approved equipment shop drawings to suit the specific requirements of the equipment.
- E. Mechanical equipment and wiring furnished and/or installed under the Electrical Section shall be installed in locations and in such a manner as required by the HVAC and Plumbing Section or as directed. The Electrical Contractor shall refer to all other Sections of these drawings and specifications and coordinate the work to provide complete and correct power wiring for HVAC and Plumbing work.
- F. If substitution of controls or mechanical equipment for that specified requires any changes in the electrical work, any extra cost of the equipment or electrical work will be the responsibility of the Contractor.
- G. Provide manual thermal protection for all motors for which a magnetic motor starter is not indicated and which are not integrally equipped with thermal protection.
- H. Provide 120V power to each system control panel and time clock requiring a source of power to operate.

2.2 MOTOR CONTROLLERS:

- A. Provide motor starters-controllers for all equipment as part of the work of this Division except where specifically indicated otherwise.
- B. Motor starters shall be adequately rated and shall match the requirements of the motors which they serve. Verify the motor horsepower, voltage, phase, speed characteristics, and all other motor parameters, with the equipment supplier prior to submitting on motor control equipment and prior to installing motor branch circuits. If discrepancies are discovered, notify Owner's representative immediately and request direction.
- C. Set the motor short circuit protectors in accordance with the manufacturers recommendations at the lowest value which will permit starting and accelerating the load up to rated speed.
- D. Size overload elements specifically for each motor as determined by the service factor and full load current data shown on its nameplate.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Execution shall conform to pertinent requirements of other sections of this Division.
- B. Electrical services and connections to the equipment of other Divisions, described in this specification and shown on drawings, are in accordance with the requirements of the equipment specified. If substitute

equipment is provided in lieu of the specified equipment, revise the services and connections at no cost to the Owner. Verify electrical requirements with the equipment supplier.

3.2 INSTALLATION:

- A. The locations of equipment points of connection as indicated on drawings are approximate only. Rough-in installation shall be in accordance with approved rough-in and/or shop drawings prepared by the Sub-Contractor/Supplier of the equipment.
- B. Provide special receptacles and matching attachment caps where cord connections for equipment are required.
- C. Motors and Vibrating Equipment: Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid tight UV resistant PVC coated, flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, and locations subject to seepage or dripping of oil, grease, or water.

END OF SECTION