PART 1 - GENERAL

1.1 REGULATIONS, CODES & FEES

A. Refer to General Conditions in Division 1.

B. Comply with all applicable Federal, State, and municipal laws and regulations.

C. Additional regulations include, but not limited to:
   1. American Society for Testing Materials (ASTM)
   2. American National Standards Institute (ANSI)
   3. Association of Edison Illuminating Companies (AEIC)
   4. Edison Electric Institute (EEI)
   5. Institute of Electrical and Electronics Engineers (IEEE)
   6. Insulated Power Cable Engineers Association (IPCEA)
   7. National Electrical Manufacturer's Association (NEMA)
   8. National Fire Protection Association (NFPA)
      a. National Electrical Code, NFPA No. 70
      b. National Fire Codes, published by NFPA
   10. Local Electrical Code
   11. Local Utility Standards
   12. Underwriters Laboratories (UL)

D. Each item of equipment and material shall conform to requirements of these applicable publications which make them most suitable in the opinion of the Architect/Engineer or Owner for environmental conditions where they shall be installed.

E. The Contractor shall also be responsible for adherence to all rules, requirements and specifications as set forth above. Ignorance of any rule, requirement or specification shall not be an excuse for non-conformity. The Contractor is not to proceed with non-conformance work, but report to Engineer for further action.

F. Items which are within scope of items tested by Underwriters Laboratories, Inc., or other suitable nationally recognized independent testing laboratories shall have their conformance with these applicable publications evidenced by attachment of authorized seal, label, or stamp of said testing laboratories.
G. Approval of items, whether evidenced by seal, label, or stamp, shall not absolve Contractor from compliance with requirements of Contract Documents.

H. Secure necessary permits and pay all required fees applicable to the work in Division 16.


1.2 ELECTRICAL EQUIPMENT SPECIFIED IN OTHER DIVISIONS

A. Intent: It is the intent of these specifications that the Contractor will provide the power supply wiring from the panel through the disconnects (if required) to controllers and from the load contacts of the controllers to the motor or other loads, unless specifically noted otherwise. Except as otherwise noted, the control circuit shall be provided by the Contractor furnishing the equipment so that the responsibility for the equipment and its control circuit rests with one Contractor. Where the power supply circuit is also the control circuit, such as would be the case in a unit heater with a line voltage thermostat, a water heater with a line voltage aquastat, a kitchen disposal with a line voltage solenoid valve, etc., the wiring shall be included under Division 16.

B. Control wiring circuits at any voltage, when not part of power wiring and isolated with control power transformers and/or interposing relays, shall be provided under the Division responsible for control wiring and/or the equipment involved and excluded from Division 16 work.

C. Refer to the Site, Architectural, Structural, Plumbing, Fire Protection, and Heating Ventilating and Air Conditioning drawings.

D. Provide all power supply wiring to equipment and systems provided by others as part of this project work.

E. Provide disconnect switches where required by the Code, as shown and scheduled.

F. Receive and store controlling equipment as necessary and be responsible for proper sizing of thermal trips. Unless otherwise noted, all motor controllers shall be installed by this Contractor.

1.3 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

A. General

1. Schedule system checkouts when work is complete and ready for final inspection.

2. Notify the Architect/Engineer and the Owner at least 48 hours in advance.

3. All test equipment and set-up shall be provided by the Contractor.

4. Electrical energy for system checkouts will be furnished by the Owner.

B. Power Distribution System

1. On a feeder-by-feeder basis, energize all loads simultaneously or as directed by the Architect/Engineer or Owner for a period of two hours.

2. Check for load balance among phases on all lighting or appliance panel feeders.
3. Correct phase imbalance, if necessary, or as directed by the Architect/Engineer; correct defective equipment or workmanship immediately.

C. Lighting Systems
   1. Demonstrate that all lighting fixtures will operate.
   2. Demonstrate that all lighting switches, contactors, timers, photo-electric controls, etc., as applicable will operate as shown or specified.
   3. Demonstrate that all dimming systems are fully operational.

D. Other tests as specified in individual sections.

1.4 REPORTS

A. The items listed below are all specified elsewhere; they are listed below for reference and convenience and are not limited thereof.

B. The Contractor shall submit all required reports to the Architect/Engineer before submission of his request for final payment.

C. Submit individual reports for each of the following:
   1. Power distribution system feeder load balance tests.
   2. Lighting systems operational tests.

1.5 RECEIPTS

A. The Contractor shall obtain written receipts as applicable from the Owner's authorized representative for each of the following items or systems listed below. (The Contractor shall submit copies of the receipts to the Architect/Engineer before submission of his request for final payment):
   1. Certification of complete system; this certification may be part of the report in paragraph "REPORTS" above.
   2. Instruction of Owner's authorized representatives.
   3. Bound copies of wiring diagrams, catalog "cuts," maintenance instructions, spare parts lists, etc.
   4. Guarantees and service contracts.

B. Submit receipts for each of the following:
   1. Spare fuses.
   2. Panel and cabinet keys.
   3. Spare lamps.

PART 2 - PRODUCTS

2.1 ELECTRICAL EQUIPMENT AND MATERIALS
A. New, unless otherwise indicated.

B. Do not use asbestos or material containing asbestos.

C. Do not use mercury or material containing mercury.

2.2 EQUIPMENT SUPPLIERS AND MANUFACTURERS

A. Major equipment for communication system, fire alarm system, and emergency power system shall be installed under the direct supervision of a factory authorized service agent.

B. Supplier shall maintain an adequate supply of spare parts and have technical personnel available to make repairs to systems within twenty-four (24) hours after they are notified by Owner.

C. Shop drawings shall be disapproved if not accompanied by proof that the foregoing has been complied with.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Erect equipment in a neat and workmanlike manner; align, level, and adjust for satisfactory operation; install so that connecting and disconnecting of conduit and accessories can be made readily, and so that all parts are easily accessible for inspection, maintenance, and repair.

B. Electrical equipment such as transformers, motor control centers, and welding stations shall be installed as shown on the drawings, as specified herein and in accordance with the equipment manufacturer’s installation instructions. All equipment shall be installed plumb and secure and shall be cleaned following the installation. All mechanical connections shall be tight and all electrical connections shall be made in accordance with the equipment connection diagrams or drawings. Install floor plates (14 GA. galvanized) under indoor or outdoor equipment to prevent rodent entry.

3.2 MATERIALS AND PROPERTY PROTECTION

A. Follow manufacturer's recommendations for protection of equipment and materials during storage, construction, and startup. Protect equipment outlets, pipe, and conduit openings with temporary plugs or caps.

3.3 COORDINATION

A. Where job conditions require reasonable changes in indicated locations or arrangements prior to roughing, make such changes without extra cost to Owner.

B. Adjust work to avoid obstacles anticipated or encountered during and after the construction of the project.

C. Items included under coordination shall be:

1. Scheduling, proposed routing, critical dimensions, with all other trades prior to roughing and equipment installation.
2. Power wiring, control wiring, and interlocks shall be coordinated with all other trades furnishing power consuming equipment prior to submission of wiring diagrams in applicable submittals.

3. Contractor shall study and compare all Contract Drawings, Specifications, and other instructions, and shall at once report to the Architect/Engineer any error, inconsistency or omission which he may discover.

4. All pre-bid coordination with utilities to determine exact terminal point locations, conduit routings, charges, etc.

5. All the electrical work shall be coordinated with the accepted practices and products by Owner.

6. Coordinate shipping dates of Owner-furnished items to follow closely with the construction scheduled.

3.4 WORKMANSHP

A. Complete electrical installation shall be made in a neat and workmanlike manner in conformance with best trade practice or modern electrical shops by competent, experienced mechanics, and to the full satisfaction and approval of the Architect/Engineer.

1. Remove and replace all work rejected as defective, nonoperational or not in conformance with intent of this Contract.

3.5 FLOATING BARGES

A. Electrical installation in floating barges shall comply with all requirements of NEC Article 553. All wiring shall be in EMT or RGS or be Type MC cable without PVC jacket.

3.6 DIMENSIONS, ELEVATIONS AND LAYOUTS

A. Verify dimensions and elevations shown or scaled on drawing by actual field measurements after building construction or alterations work has progressed to the point where such measurements may be taken.

1. Advise Architect/Engineer in writing regarding those critical dimensions which must be held by other Trades as they perform their work.

2. Assume full responsibility for accuracy of all work under the Contract and make corrections as required.

3. It shall be this Division's responsibility to coordinate with all other trades and separate equipment contracts regarding mechanical equipment layouts, space requirements, mounting details, "roughing-in" dimensions, and for items substituted for those specified herein to avoid conflict.

4. Arrange for disassembling large pieces of equipment for entry into buildings as necessary to pass through available openings.

B. Layouts
January 7, 2004

1. Layouts of feeders and wiring shown on drawings are diagrammatic, and shall be construed as such, intended to show scope of work and general arrangement.
3.7 CLEANING, POLISHING, AND PAINTING

A. Remove labels, dirt, paint, grease, and stains from exposed devices, equipment, and fixtures provided under this Contract.

B. Clean and polish same to present a first-class, workmanlike job ready and suitable for use by occupants.

C. Vacuum clean equipment, including current conducting components and compartments, immediately before testing and immediately before putting equipment into service.

D. Touch-up or fully paint with matching colors all marred, scratched or rusty surfaces of equipment installed.

E. All metal surfaces of electrical enclosures shall be factory painted inside and outside with manufacturer’s standard finish suitable for corrosive salt air atmosphere. The Contractor shall obtain from the equipment manufacturer sufficient paint to repair all scratches and other damage that may occur during shipment or erection. Materials not painted in the factory, such as fabricated racks, supports, junction boxes, and similar items, shall be field-painted with one coat primer and two coats of two part epoxy paint. The method of application and type of paint shall be submitted for approval.

3.8 PROTECTION OF WORK DURING CONSTRUCTION

A. Keep conduit fittings, boxes, raceways, cabinets, and enclosures closed to prevent entrance of foreign matter.

B. The Contractor shall be fully responsible for his own materials and equipment whether or not they have been paid for by the Owner and if any such materials or equipment are stolen, lost, or damaged, they shall be replaced by the Contractor without additional cost to the Owner. This includes the proper protection of all finished surfaces of equipment, escutcheon plates, etc., against damage by paint, plaster, dirt, etc., until other trades have completed their work.

3.9 CIRCUIT NUMBERS

A. Circuit numbers shown on the drawings are for reference and may be rearranged as required for load balancing purposes and duly recorded.

B. Rearrangement of circuit numbers may be made to suit the convenience of the Owner and duly recorded.

C. The fixtures, devices, or equipment shown on a common circuit may not be rearranged to other circuits without written permission of the Architect/Engineer.

D. If circuit numbers or connections are changed from those shown on the drawings for any reason, the changed items should be so noted on the "Project Record Documents."

E. In any case, the circuits and numbers used shall be entered in the circuit directory of the respective panel.

3.10 IDENTIFICATION

A. In addition to the standard manufacturer’s nameplate, phenolic nameplates shall be provided for each motor starter, enclosed circuit breaker, safety switch, push button station, indicating light, cabinet,
panelboard, transformer, and each major piece of equipment. Nameplates shall designate the function of the equipment for which they are used and the number assigned to the unit by E.B. Division.

B. The designations shall be submitted for approval with the shop drawings. Nameplates shall be three-layer black-white-black engraved to show white letters on black background. Letters shall be upper case. Nameplates 1-1/2 inches high and smaller shall be 1/16 inch thick with lettering ¼ inch high. Nameplates larger than 1-1/2 inches shall be 1/8 inch thick with engraved lettering of suitable height. Edges of 1-1/2 inch high nameplates shall be beveled. Nameplates 1/8 inch thick shall be fastened by means of nonferrous metal screws. Nameplates 1/16 inch thick shall be attached with Eastman 910 adhesive or equivalent. Hand lettering or marking is not acceptable. All outlets/receptacles shall be labeled to indicate the panel and circuit from which they are fed.

C. Label all feeders where they pass through pull boxes with permanent tags designating feeder number and destination.

D. Provide complete typewritten circuit directories under transparent cover in all panels. Identify areas as directed by the Owner.

E. Identify opposite termination of each empty conduit at both ends.

F. Phase identification where required may be accomplished with colored insulation, colored tape at each termination and junction point, or with printed adhesive-type wire markers or sleeves at each termination and junction point.

3.11 EQUIPMENT FOUNDATIONS, AND SUPPORTS

A. The Contractor shall provide all concrete pads, steel supports, platforms, hangers, and carriers required for the proper installation of his conduit and equipment, except where specifically noted otherwise.

3.12 EXISTING SERVICES

A. Active: When encountered in work, protect, brace, support existing active sewers, gas, electric, water, and other services where required for proper execution of work. If existing active services are encountered that require relocation, make request in writing for determination. Do not prevent or disturb operation of active services that are to remain. Repair broken service at no cost to the Owner. Record on Contractor's job site drawings set.

B. Inactive Services: When encountered in work, remove, cap, or plug inactive services. Notify utility companies or agencies having jurisdiction; protect or remove these services as directed. Record on "Project Record" drawings.

C. Interruption of Services: Where work makes temporary shutdowns of services unavoidable, shutdown at night or at such times as approved by the Owner, which will cause least interference with established operating routine. Arrange to work continuously, including overtime if required, to assure that services will be shut down only during time actually required to make necessary connections to existing work.

D. Shutdown or interruption of existing services shall be closely coordinated with the Owner.
3.13 TESTING

A. The Contractor shall test all wiring and connections for continuity and grounds and shall demonstrate by megger test the insulation resistance of any circuit or group of circuits. Where such insulation resistance tests indicate the possibility of faulty insulation the contractor shall, at his own expense, locate the point of fault, replace same with new material, and demonstrate by further test the elimination of such fault.

B. Tests shall be made during installation to verify continuity of the grounding systems. Each ground rod shall be tested separately with a heavy duty megger ground tester. Auxiliary ground rods for the test shall be driven not less than 50 feet from the tested ground rod. The ground resistance of each ground rod shall not exceed 25 ohms. The contractor shall conduct ground tests for measuring grounding resistance for each grounding system installed.

C. The Contractor shall demonstrate in the presence of the Owner, that the equipment operates in accordance with the requirements of this specification. The contractor shall furnish all instruments and personnel required for the tests and the Owner will furnish the necessary electric power. All switches, circuit breakers, starters, controller, push-buttons, and indicating lights shall be operated no less than five times each to prove their proper operation. Testing of fire alarm systems shall be performed under supervision of qualified fire alarm technician representing the fire alarm equipment manufacturer.

D. All tests and inspection results shall be recorded by the contractor on forms approved by the Owner before testing is started. The test records shall be certified by the Contractor.

3.14 ACCEPTANCE TESTING OF ALL NEW ELECTRICAL DISTRIBUTION APPARATUS AND CABLE

A. Acceptance testing is to be performed by a National Electrical Testing Association (NETA) member electrical testing contractor using certified NETA journeymen test technicians or a qualified service, repair or testing contractor approved by the Owner. Acceptance testing shall be performed on all distribution switchgear, substations, distribution transformers, medium voltage cables, substation low voltage circuit breakers, high voltage circuit breakers, protective automatic transfer switches, and generators.

B. All testing is to be in strict conformance with NETA standards for acceptance testing of electrical distribution apparatus, publication 1.001, supplement A with ANSI, IPECA specifications all inclusive. The testing shall be documented and three (3) copies immediately forwarded to the Engineer. All deficiencies and/or equipment which fails to pass the acceptance tests shall be repaired/replaced as directed by Owner’s representative, and retested at the Contractor's expense.

C. All new medium and high voltage cable shall be tested after placed in duct line, but before final terminations, in accordance with the aforementioned standards by NETA and IPECA.

D. After new medium and high voltage cable has been tapped into existing cable system, an additional 2500V D.C. megger and D.C. hypotential test is to be made which does not exceed the maximum test values for maintenance tests on switchgear or cable, whichever is lower, and in accordance with NETA, ANSI, NEMA, and IPECA recommendations.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Conduits and fittings.
B. Surface raceways.
C. Wire and cable.
D. Boxes.
E. Wiring devices.
F. Cabinets and enclosures.
G. Supporting devices.
H. Through wall, through floor sealing assemblies.

1.2 RELATED SECTIONS
A. Section 07270: FIRESTOPPING.

1.3 SUBMITTALS
A. Conduits and Fittings: Product data.
B. Surface Raceways: Product data.
C. Wire and Cable: Product data.
D. Boxes: Product data.
E. Wiring Devices: Product data.
F. Cabinets and Enclosures: Product data.
G. Supporting Devices: Product data.
H. Through Wall and Floor Seal Assemblies: Product data and/or shop drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. As indicated in individual paragraphs.
2.2 WIRE AND CABLE – 600 VOLT

A. Conductors shall be 98% conductivity, annealed copper with a minimum of 600-volt insulation.

B. Cable installed inside shall be type THHN/THWN for No. 3 and smaller, and type XHHW for No. 2 and larger, or as noted on drawings. Cable installed outside or underground shall be type RHH/RHW/USE/VW-1 with an insulation of ethylene propylene, chlorosulfonated polyethylene composite, type "OKOLON" as manufactured by Okonite Company or approved equal. Insulation shall be rated 75 degrees C for wet locations and 90 degrees C for dry locations. All conductors cables shall conform to the requirements of the National Electrical Code. Conductors No. 8 AWG and larger shall be stranded. Control wiring in switchgear shall be type SIS.

C. Flat Conductor Cable, transition/junction boxes, connectors, receptacles, etc. shall be "The Versa-Trak" system, as manufactured by Thomas & Betts. Cables feeding Haworth Partition System shall be 8 wire.

PVC Roll Tape shall be installed between the floor and all power conductor cables.

D. Other special types as specified or required by code; for fixtures, motors, and special systems.

E. Wire and cable shall be delivered to the site of the project in original packaging, or on factory reels, and fully identified with tags or labels indicating the manufacturer's name and date of manufacture. In addition, the name of manufacturer, insulation type, voltage rating, and wire size shall be clearly and permanently imprinted throughout the length of each cable. Cable reels shall be protected against damage during transportation to the job site and until installed and accepted by the Owner representative.

2.3 CONDUITS AND FITTINGS

A. Rigid Galvanized Steel (RGS) conduits shall be hot-dipped galvanized steel. Conduit shall be of standard (10' -0") length with galvanized threads supplied with one coupler and one thread protector. All joints and fittings shall be threaded.

B. Intermediate Metal Conduit (IMC) shall be galvanized. IMC shall not be acceptable for hazardous locations.

C. Electric Metallic Tubing (EMT) shall be galvanized steel. EMT shall be used only where not subject to physical damage.

D. Flexible Metal Conduit: For recessed fixtures - not more than 6 feet from each junction box, for connections to switches and receptacles in existing walls. Not for feeder or branch circuit wiring. Must have individual, insulated, copper grounding conductor.

E. Flexible Liquid-Tight Conduit: For direct connections to all motors, transformers and mechanical equipment with rotating equipment. Length of conduit at each connection not more than two feet.

F. Polyvinyl chloride conduit (PVC) shall be heavy wall schedule 40 or 80, rated 90 degree C. All conduit, fittings and cement shall be produced by the same manufacturer. Joints shall be solvent welded in accordance with the manufacturer's instructions. PVC conduit shall not be used in exposed locations, unless approved by Owner.

G. Underground conduits shall be either rigid galvanized steel, or polyvinyl chloride, encased in concrete.
H. RGS and IMC fittings shall be of the threaded, cast steel type, equipped with covers fastened by screws and solid neoprene gaskets. Covers for conduit fittings used in wet and outdoor locations shall be cast steel. Other covers may be sheet steel except where otherwise required by the National Electrical code or shown on the drawings.

I. EMT fittings installed inside may be of the Set Screw Type. Fittings installed outside shall be of the compression type.

2.4 OUTLET, JUNCTION, AND PULL BOXES

A. Switch and outlet boxes installed indoors and concealed, shall be zinc-coated, sheet metal type provided with screw fastened covers. Switch and outlet boxes installed exposed indoors shall be cast metal with no knockouts. All boxes installed outdoors shall be of cast metal with threaded hubs and classified NEMA 4, or 4X.

B. All fabricated junction boxes shall have welded seams and be constructed in a manner to exclude water and dusts. Junction boxes having a volume of 8 cubic feet, or greater, or that exceed 2 feet in the longest dimension, shall be constructed with angle-frame internal supports. Covers shall be held in place with stainless steel hexagon head bolts and shall not exceed 3 feet or be of such size and weight that one man cannot handle it safely. Fabricated junction boxes located where exposed to the weather or oils and corrosive fumes shall have conduit couplings welded into the box where conduit access is desired. Male threaded bushing shall be screwed into the welded coupling inside the box. Covers shall be held in place with stainless steel hexagon head bolts and shall be made watertight with 1/8" gasketing material.

C. The use of the pressed steel outlet boxes shall be definitely restricted to indoor concealed locations. Non-metallic boxes shall not be used. Each box shall have sufficient volume to accommodate the number of conductors in the box, in accordance with the requirements of the National Electrical Code. Boxes shall be not less than 1-1/2" deep. Ceiling and bracket outlet boxes shall not be less than 4" square. Pull boxes shall be constructed of code gauge galvanized sheet metal, and shall be furnished with screw fastened covers.

D. Special boxes shall be sized as called for in the drawings or as required and approved during construction.

E. Terminal Cabinets: NEMA 12 enclosures (14 gauge steel) having doors with continuous hinges, key locking handles, 12 gauge steel panels inside and gray finish - Hoffman or equivalent.

2.5 HANGERS, SUPPORTS, AND INSERTS

A. Conduit Supports: Any one or combination of concrete inserts, beam clamps, pipe clamps, full threaded hanger rods with nuts, washers, etc., strut steel "C" channels and accessories for trapeze assembly steel beam mounting or wall mounting applications. All items shall be galvanized or rust resistant and non-corrosive.

2.6 WIREWAY AND AUXILIARY GUTTERS

A. Rigid 16 gauge steel body with shop painted gray finish, hinged latching type covers.

B. Raintight-gasketed cover; no prepunched knockouts for exterior use.

C. Conduit fittings are not to be used as wireways or auxiliary gutters.
2.7 WALL SWITCHES
A. Wall switches shall be the totally enclosed, specification grade. Wiring shall be to the screw type or clamp type terminals. Switches shall be either SPST, three-way or four way, rated as shown on the drawings and of specification grade.

2.8 RECEPTACLES
A. Single and duplex receptacles shall be rated as shown on the drawings. Construction shall be of specification grade with three-wire grounding, polarized tandem slots, and U-shaped ground slot. Contact arrangement shall be such that contact is made on two sides of an inserted blade. The third grounding pole shall be internally connected to the grounding yoke. Wiring shall be to the screw type or clamp type terminals. Receptacles shall be labeled with panel and circuit number.

2.9 DEVICE PLATES
A. One-piece device plates shall be provided for all outlets to suit the devices installed. Sectional device plates shall not be used. Plates shall be constructed of stainless steel to specification grade.

2.10 SURFACE METAL RACEWAYS
A. Code gauge steel, baked enamel ivory finish.
B. Matching fittings and connectors.
C. As manufactured by Wiremold.

2.11 PLUG MOLD MULTI-OUTLET ASSEMBLY
A. Code gauge steel, baked enamel ivory finish.
B. Match fittings and connectors.
C. Single circuit with NEMA 5-15R outlets.
D. As manufactured by Wiremold V-2000.

2.12 POWER/DATA WIREWAY
A. Code gauge steel, baked enamel ivory finish.
B. Approximately 4-3/4 inches high by 1-3/4 inches deep by length as shown.
C. Two compartment with divider for power and data wiring.
D. Power outlets shall be NEMA 5-20R duplex, data outlets shall be "blank single gang plate."
E. As manufactured by Wiremold V-4000 with stainless steel outlet covers.
2.13 CONDUIT, THROUGH-WALL AND FLOOR SEALS

A. Below Grade
   1. Provide hydrostatic sealing to minimize water entrance.
   2. Provide electrical insulation between conduit and wall to prevent cathodic reaction.
   3. O.Z. Gedney, Thunderline (Link Seal), or approved equivalent.
   4. New Construction: Provide steel pipe sleeve with anchor and waterstop cast into wall.
   5. Existing Construction: Core drill opening in the wall.

B. Above Grade
   1. Provide fire rating equal to the rating of the barrier penetrated.

C. Conduit Sleeves for Open Cable Work
   1. Seal around conduit as per Paragraph A. or B. above.
   2. Seal empty conduit sleeves left for future use with threaded metallic caps.
   3. Seal the void between cable(s) and conduit sleeves in use below grade with appropriate sealing bushing. O.Z. Gedney, Thunderline, or approved equivalent.
   4. Seal the void between cable(s) and conduit sleeves in use above grade with appropriate caulk, putty, or foam type firestop material.

PART 3 - EXECUTION

3.1 WIRE AND CABLE

A. Code size minimum, larger if indicated or required - #12AWG minimum for power and #14AWG minimum for control wiring. Full size from source to load, neutral wires same size as phase wires. Wire sizes for special systems shall be as indicated or required by the systems manufacturers.

B. Conductor Identification
   1. All power conductors shall be identified by existing color coding or as follows:

<table>
<thead>
<tr>
<th>120/208 Volt System</th>
<th>277/480 Volt System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A - Black</td>
<td>Phase A - Brown</td>
</tr>
<tr>
<td>Phase B - Red</td>
<td>Phase B - Orange</td>
</tr>
<tr>
<td>Phase C - Blue</td>
<td>Phase C - Yellow</td>
</tr>
<tr>
<td>Neutral - White</td>
<td>Neutral - White or Gray</td>
</tr>
<tr>
<td>Ground - Green</td>
<td>Ground - Green</td>
</tr>
</tbody>
</table>

   All power conductors running through manholes, handholes, vaults, switchgear, and junction boxes shall be identified with permanently attached non-corrosive labels indicating the cable function, circuit number and parallel cable number, as approved by the Owner. Labels shall consist of one (1) inch high black on yellow polypropylene letters. Letter holders shall be polypropylene and be held on cables with nylon self-locking straps. The labels shall be the
underground E-Z Tag System as manufactured by Almetek Industries, Inc. or approved equal. Cables leaving a manhole, vault or switchgear shall be labeled with the next manhole or vault number.

Conductor identification shall also be provided within each enclosure where a tap, slice, or termination is made. Terminal and conductor identification shall match that shown on approved shop drawings. Hand-lettering or marking is not acceptable.

2. Control wiring shall be identified by self-sticking printed markers, permanently attached or equivalent means as approved by Owner. The identification of each control wire shall consist of a unique number which should include the equipment designation. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Control circuit terminals of equipment shall also be identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

C. Wiring shall not be installed until the raceway system has been completed. The Contractor shall thoroughly clean the inside of all conduits of dirt, moisture, or other foreign materials before pulling wire and cable. Wires and cables shall be pulled in conduits after an application of suitable lubricant that will have no injurious effect on the insulation of the conductor. No oil or grease shall be used. Wires shall be installed without splices except at junction, outlet and pull boxes. Splices in branch circuits shall occur only where such circuits divide as shown on the drawings. Sufficient wire shall be left at all outlets and terminals for connections to equipment, fixtures, and devices. All splices, taps, and connections shall be made with approved solderless mechanical or compression connectors. All wiring splices, terminations, and connections shall be completely wrapped and taped with electrical tape to a thickness at least equal to the thickness of the insulation of the conductors. Vertical cable support shall be provided as required by the National Electrical Code.

D. Wires and cables of different systems not to be in the same type of raceway systems. Power wiring not to be run in the same raceways for control wiring for the same system, unless otherwise indicated.

E. All the wiring shall be in conduits or other metallic raceways unless otherwise indicated.

F. Cables shall be installed according to the manufacturer's instructions, including pulling tension, lubricating compounds, temperature, splices, and terminations. All outside and underground splices shall be waterproof.

3.2 CONDUITS AND FITTINGS

A. Raceway sizes shall be as indicated on the drawings or as required by the National Electrical Code.

B. The Contractor shall assume full responsibility for all necessary field measurements. Should any mechanical, rebar, or structural difficulties prevent setting of equipment or conduit indicated on the plans, the necessary deviations therefrom, as determined by the Owner, shall be made without additional cost to the Owner. Drawings are diagrammatical only, except where dimension are given. Precise locations and routing shall be determined in the field.

C. Conduits shall be concealed, embedded, or exposed as shown on the drawings. Conduits shall be installed in accordance with the requirements of the National Electrical Code. All junction boxes, cabinets, switches, and other electrical equipment shall be solidly attached prior to installation of conduits. Field-made bends and offsets shall be avoided where possible, but where necessary shall be made with an approved hickey or conduit bending machine. The conduits shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right-angle turns consisting of cast metal equivalent of four 90 degree bends between pulling points. Runs exceeding 150 feet shall not have more than the equivalent of two 90 degree bends between pulling points. Square cuts shall be made on all field cut conduits. After cutting and threading, the conduits
shall be reamed, to remove burrs, thoroughly cleaned and coated with a conductive compound. Conduit connections shall be up tight to provide good electrical conductivity throughout.

D. A minimum clearance of 12 inches shall be maintained for conduits that are installed in the vicinity of uninsulated hot pipes or hot surfaces. Sleeves and inserts shall be furnished and installed as required or shown on the drawings.

E. The Contractor shall exercise the necessary precautions to prevent the lodgment of dirt, plaster, or trash in conduit, fittings, and boxes during the course of installation. A run of conduit that has become clogged shall be entirely freed of the accumulations or shall be replaced. Open conduit ends shall be carefully closed during the construction to prevent foreign materials entering the conduit. Conduits that have been crushed or deformed in any way shall not be installed. Insulating bushings shall be provided on the conduits at the terminations. Grounding type insulated bushings shall be installed on all conduit terminations where a grounding conductor is carried.

F. All necessary openings in walls and floors shall be cut and repaired in a neat manner. No sleeves shall be set, nor openings cut in structural beams or columns without the specific approval of the Engineer.

G. Conduit shall be installed in such a manner as to insure against moisture traps. Open conduit shall be sealed with conduit closures during course of construction to prevent entry of foreign material. Where wire or cable is installed in conduit on the outside of the buildings, all conduit connections, conduits and fittings shall be weathertight. Where conduit passes between areas subject to different temperatures, the conduit shall be sealed with Duxseal or approved equal to prevent interchange of air and formation of condensation.

H. All installed spare/future conduits shall be thoroughly cleaned of dirt, moisture, or other foreign materials. Conduit measuring tape of water-proof polyester with measurements permanently printed every foot and a tensile strength of 130 lbs shall be installed in all spare/future conduits. Tape shall be tied off at both ends.

I. Seals around conduits through walls and floors - airtight in aboveground locations, hydrostatic in below-grade applications and matching the fire rating of the barrier crossed. See Division #07270. Seals to be so constructed to provide protection against cathodic reaction.

J. Outside diameter of conduits in concrete slabs not to exceed 1/3 of a slab thickness. Minimum concrete cover not less than 3/4 inches. Coordinate with structural work. Minimum separation of one and a half times the diameter of the larger of the two adjoining conduits or more as required by the Engineer.

K. Conduit runs shall be coordinated with piping and ductwork under other Divisions for maximum utilization of the space available and to avoid conflicts.

L. Expansion couplings as required by NEC, at building expansion joints and for straight runs 200 feet or longer.

3.3 OUTLET BOXES

A. Bar hanger for boxes in studs or hollow partitions. Use of locknuts for fastening conduits to boxes.

B. Outlet boxes to be located symmetrically using actual building layout and dimensions where possible. Center boxes in tiles, masonry units and other regular or patterned material. Local wall switch boxes to be located on strike side of doors.

C. Firmly supported from structural members, independent of conduits attached to the boxes.
D. Surface-mounted boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, and to steel work with machine screws or welded studs. Flush-mounted boxes shall be cast in concrete or grouted into hollow masonry walls. Threaded studs driven in by power charge and provided with either lockwashers and nuts or nail-type nylon anchors are acceptable in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces cast metal boxes threaded to support. Where bar hangers are used the bar shall be attached to raceways on opposite sides of the box and shall be supported with an approved fastener not more than 24 inches from the box. Boxes installed in concealed raceway systems shall be set flush with the finished surfaces. The location of all boxes shall be easily accessible and any interference with mechanical equipment or structural features shall be reported to the Engineer prior to installation.

3.4 PULL BOXES

A. Where indicated or required for wire pulling convenience.

B. Firmly and independently supported from structural members.

C. Accessible.

D. Where several feeders pass through a common pull box the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Unused or spare openings in the boxes shall be thoroughly sealed.

3.5 HANGERS, SUPPORTS AND INSERTS

A. Chain, wire or perforated strap supports are not acceptable.

B. Construction channel frames for wall-mounted equipment, unless noted otherwise.

3.6 WIREWAY AND AUXILIARY GUTTERS

A. Securely and continuously anchored at maximum of 5 foot intervals.

B. Size as indicated or NEC minimum.

3.7 WALL SWITCHES

A. Mounted 4 to 13 inches from trim on latch side of door unless indicated otherwise. Long dimension vertical wherever possible.

B. Switches shall be installed as shown on the drawings. Where more than one switch is shown for one indoor outlet box, they shall be installed under one plate.

3.8 RECEPTACLES

A. Mounted in column enclosures and in permanent walls as applicable and as indicated. Long dimension vertical, wherever possible.
B. Outlet ground pin shall be down.

C. Receptacles shall be located and installed as shown on the drawings. Locations shall be easily accessible and any interference with mechanical equipment or structural features shall be reported to the Owner’s Representative prior to installation.

3.9 DEVICE PLATES

A. Device plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Device plates shall be installed vertically with an alignment tolerance of 1/16 inch.

3.10 SURFACE METAL RACEWAYS

A. Securely attached to building construction with runs parallel or normal to structural elements with minimum number of couplings and fittings.

B. Separate green grounding conductor in all the raceways.

3.11 POWER/DATA WIREWAY

A. Locate as shown.

B. Surface mounted.

C. Power/data outlet spacing as shown.

3.12 OFFICE RECEPTACLES, MULTI-OUTLET PLUGMOLD, AND HAWORTH MULTI-OUTLET PLUGMOLD SYSTEMS

A. Installation of Haworth, shall be in accordance with Haworth instructions and be by Haworth trained personnel. Assure special holding clips are always installed.

B. All new Haworth installations shall be eight (8) wire system. Five (5) wire components shall be limited to replacement only. Existing five wire systems serving data processing equipment shall be checked for neutral conductor loading. Eight wire Haworth shall be connected with three phase wires, three neutral wires and two ground wires.

C. Each 120volt office circuit shall have a dedicated neutral wire. A common neutral wire for two or three phases shall not permitted.

D. Cables from panels shall be sized according to the NEC, but as a minimum conform to the following:

1. Where the cable length from the distribution panel to the first point of utilization in the branch is less than or equal to seventy (70) feet, then the wire size shall be #12 copper.
2. Where the cable length from the distribution panel to the first point of utilization in the branch circuit is greater than seventy (70) feet and less than or equal to one hundred ten (110) feet, then the wire size shall be #10 copper.
3. Where the cable length from the distribution panel to the first point of utilization in the branch circuit is greater than one hundred ten (110) feet and less than or equal to one hundred eighty (180) feet, then the wire size shall be #8 copper.
4. Where the distance from the distribution panel to the first point of utilization in the branch circuit is greater than one hundred eighty (180) feet the wire shall be sized by the Engineer.
E. Quantity of receptacles shall not exceed 8-15 amp receptacles per 20 amp circuit unless otherwise limited by NEC.

F. Surge protected receptacles shall be provided for computers and other sensitive equipment.

G. Initial installation/design shall be documented and limited to 10 amps per circuit. All new installations and/or rearrangements must be reviewed for loading by the Engineer.

H. Connection of following equipment to Haworth and multi-outlet plugmold is prohibited.

1. All equipment rated 12 amp and greater.
2. Copiers.
3. Space heaters.
5. Microwaves, ovens, hot plates, etc.

3.13 CONDUIT, THRU-WALL AND FLOOR SEALS

A. Coordinate with the opening or sleeves already existing or provided under other divisions or sections.

* * * * *
SECTION 16112
CABLE TRAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Cable trays.
B. Cable tray accessories.

1.2 REFERENCES
A. NEMA VE 1 Cable Tray Systems.

1.3 SUBMITTALS
A. Product data.
B. Shop Drawings: Include tray type, dimensioned layout, support points and finishes.
C. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. B-Line Systems, Inc.
B. MPHusky Corp.
C. T.J. Cope, Inc.

2.2 QUALITY ASSURANCE
A. Standard cataloged products of a manufacturer regularly engaged in the manufacture of cable tray systems with 10 years’ experience.

2.3 LADDER TYPE CABLE TRAYS
A. Tray: NEMA VE 1; Class 12B, unless otherwise indicated.
B. Dimensions: Width as indicated, minimum 4 inch load depth, unless otherwise indicated.
C. Rung Spacing: 9 inches.
D. Inside Radii of Fittings : Minimum 12 inches, unless otherwise indicated.
E. Accessories and Fittings: Manufacturer's standard clamps, hangars, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

F. Material: As indicated.

G. Finish: Natural.

2.4 WARNING SIGNS

A. Engraved Nameplates: 1/2 inch high black letters on red laminated plastic nameplate with the following wording:

WARNING! ELECTRIC USE ONLY. DO NOT USE CABLE TRAY AS WALKWAY, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES.

B. Manufacturer furnished decal may be substituted for laminated plastic nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In conformance with NEMA VE 1 requirements and in accordance with manufacturer's instructions.

B. Support each cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 12 feet maximum.

C. Use expansion connectors where indicated in NEMA VE 1.

D. Cut standard straight sections to length in field.

E. Use manufactured fittings for all bends, offsets, and junctions.

F. Install warning signs at 20 foot intervals, located to be seen.

G. Provide bonding continuity between cable tray sections and fittings in accordance with manufacturer's instructions and the NEC.

H. Where cable tray is shown running through rated walls, the tray shall be stopped at each side and the wall penetrated with 4 inch conduit sections (4-4 inch for 18 inch tray and 3-4 inch for 12 inch tray). Conduit sections which are used for cabling shall be firestopped. See Division # 07270. Unused sections shall be capped.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Pre-fabricated manholes.
   B. Manhole accessories.

1.2 RELATED SECTIONS
   A. SECTION 02200: EARTHWORK.

1.3 REFERENCES
   B. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   C. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
   D. ASTM A48 - Gray Iron Castings.
   E. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.4 SUBMITTALS
   A. Indicate material specifications, dimensions, capacities, size, and location of openings, reinforcing details, and accessory locations.
   B. Product data for accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Noted in each paragraph.

2.2 QUALITY ASSURANCE
   A. Precast: Company specializing in precast concrete structures with three year's experience.
   B. Cast-In-Place: Include all details for approval with submittal.
2.3 GENERAL

A. Equip manholes with a pulling hook opposite each conduit entrance. Construct hook of 3/4 inch galvanized stock with 3 inch diameter eye and 8 inch for anchoring in manhole wall.

B. Provide a permanently affixed ladder, avoiding contact with cables and supports.

2.4 PRECAST MANHOLES

A. As manufactured by the Fort Miller Co. or Lakelands Pre-Cast Inc. with the following:

1. Reinforcing shall meet American Association State Highway Officials requirements for H-20 loading. Submit calculations.

2. Minimum size 8 feet long by 6 feet wide by 7 feet high.

3. Wall: Minimum 6 inches thick reinforced concrete (30 inch by 30 inch manholes, minimum 4-1/2 inch thick reinforced walls).

4. Top Slab: Minimum 7 inch thick reinforced concrete (4 foot by 4 foot manholes, minimum 6 inch thick reinforced top slab - top slab not required for 30 inch by 30 inch manholes).

5. Bottom Slab: Minimum 6 inch thick reinforced concrete (30 inch by 30 inch manholes, minimum 4 inch thick reinforced bottom slab).

6. Seal all joints.

2.5 MANHOLE COVERS AND FRAMES

A. As manufactured by Campbell Foundry Co., E.L. LeBaron Foundry Co., Flockhart Foundry Co., or Woodward Foundries, with the following:

1. Clear opening of not less than 36 inches in diameter.

2. Heavy Duty Cast Iron Frame: Minimum height 6-1/2 inches with not less than 6 integral gussets and 1 inch thick flange. Flange may be round or square to fit manhole requirements and have a bearing on masonry minimum 600 square inches.

3. Round Cover: Minimum 1-1/4 inch thick cast iron, reinforced on the underside by integral cast ribs and with an unperforated, checkered surface.

4. 6 inch letters "Electric Power" cast in cover for power manholes. 6 inch letter "Communications" cast in cover for signal manholes.

5. 2 hooks for manhole cover removal.

2.6 CABLE SUPPORT ASSEMBLIES

<table>
<thead>
<tr>
<th>Steel Channel</th>
<th>Steel Support</th>
<th>Porcelain Insulators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chance</td>
<td>1225</td>
<td>1231 Series</td>
</tr>
<tr>
<td>McGraw-Edison</td>
<td>DU10B Series</td>
<td>DU9S Series</td>
</tr>
</tbody>
</table>

DIVISION 16 - 23   SECTION 16117
2.7 GROUNDING AND BONDING

A. Rod Electrodes: Copper clad ground rods minimum 5/8 inch diameter by 10 feet long.

B. Exothermic Type Weld: Cadweld Process (Erico Product Inc. - Cadweld Division).

C. Compression Connectors: Thomas and Betts Grid and Ground Rod System.

D. Grounding Electrode Conductors and Bonding Conductors: Bare copper conductors.

E. Hardware: Silicon-bronze bolts, nuts, flat and lock washers, etc., as manufactured by Burndy Corp.; OZ/Gedney.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Manholes:

1. Install manholes at depth required to suit duct bank slopes and elevations on a 5 inch layer of No. 2 crushed stones and bring top of manholes cover 2 inches above finished grade in lawns, and flush with paved surfaces of walks, roads, and parking space. Excavate first to ensure manhole will fit between possible obstructions (Pipes, ductbanks, etc.), prior to ordering. Excavate for manholes and ductbanks far enough ahead to ensure no obstructions exist to prevent proper installation of next or connecting components.

2. Floor shall slope toward an effective gravity drain located 18 inches up the side of a 30 inch deep sump. The sump must be 18 inches on a side and have a cast iron grate with 1/2 inch holes. Provide 2 inch PVC drain pipe to nearest sanitary manhole.


C. Cable Supports: Install racks, supports, and insulators of size and number to provide one insulator on each cable support assembly for each conduit entering the manhole, as follows:

1. Equip manholes with number of cable support assemblies indicated on the drawings and/or a minimum of two supports per manhole wall. Fasten cables to cable support insulators with waxed lacing twine.

2. Route cables on cable supports around periphery of manholes and the longest route possible. None of the cables, 3 feet or more in length, shall be without supports. Diagonal runs are not permitted.

D. Grounding and Bonding: In all manholes, install a 10 foot rod electrode through floor in a corner into earth below manhole with 4 inches protruding for ground connection, as follows:

1. Bond manhole cover frame, channel racks, ladder, and splices (lead sheath of splice or cable shields for nonlead type cables) to rod electrode with No. 2 AWG bare copper ground conductor. Make connection to rod electrode with exothermic type weld or compression connectors.

E. Provide excavation and backfill in accordance with applicable specifications.
SECTION 16118

DUCTBANK

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Ductbanks.

1.2 RELATED SECTIONS
A. Section 02200: EARTHWORK.
B. Section 03300: CAST-IN-PLACE CONCRETE.
C. Section 16117: MANHOLES AND HANDHOLES.

1.3 REFERENCES
A. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
B. NEMA TC 3 - PVC fittings for use with rigid PVC conduit and tubing.

1.4 SUBMITTALS
A. Shop Drawings: For ductbank.
B. Product Data: For conduit, fittings, accessories, warning tape.
C. Project Record Documents: Accurately record actual locations of exact routing of ductbank and all manholes/handholes and building penetrations.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Protect conduit from entrance of debris.

1.6 SITE CONDITIONS
A. Verify field dimensions.
B. Verify routing and termination locations prior to excavation.
C. Verify locations of manholes prior to excavation.
D. Duct bank routing is approximate unless dimensions are indicated. Route as required to complete duct system.
E. Manhole/handhole locations are approximate unless dimensions are indicated. Locate as required to complete duct system.

PART 2 - PRODUCTS

2.1 PVC CONDUIT

A. Description: NEMA TC 2; Schedule 40 concrete encased, unless otherwise indicated.

B. Fittings: NEMA TC 3.

2.2 WARNING TAPE

A. 4 inch wide, red plastic tape, continuously imprinted with "WARNING, ELECTRICAL DUCT BELOW" in 3 inch black letters. Tape shall be installed 12 inches below final grade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that excavation, base material installation, and compaction are completed.

3.2 INSTALLATION

A. Underground concrete encased electrical power duct banks shall be colored red. The amount of red oxide of iron shall be 7 percent by weight of cement. The cement and the red oxide of iron shall be blended dry before water and aggregates are added. The reinforcement and formwork shall conform to the Sections as shown on the drawing. All bends shall be gradual. Duct banks shall have a 3 inch to 100 feet minimum slope. A minimum 4/0 bare copper cable shall be encased in the concrete duct bank for the length of the duct bank and be connected at each end to the grounding system. Each manhole/handhole shall have a ground rod connected to the grounding system. All duct joints shall be sealed with approved joint sealing compound. After installation of cables, duct ends shall be packed with plastic, watertight compound Duxseal, or approved equal.

B. Install duct in accordance with manufacturer's instructions.

C. Install duct to locate top a minimum of 30 inches below finished grade.

D. Slope duct away from building entrances and toward manholes/handholes.

E. Join duct using adhesives as recommended by manufacturer.

F. Wipe duct dry and clean before joining. Allow joint to cure for 20 minutes minimum.

G. Install no more than the equivalent of three 90 degree bends between pull points.

H. Terminate duct using plastic end bells and plugs in manhole and building.

I. Stagger duct joints at least 6 inches.

J. Use separator chairs spaced no greater than 4 feet.
K. Securely anchor duct to prevent movement during concrete placement and backfill.
L. Connect to existing concrete encasement or manholes using dowels.
M. Encase in reinforced concrete.
N. Provide 3/16 inch diameter nylon pull wire in each duct.
O. Swab duct and install suitable caps to prevent entry of moisture and debris.
P. Interface installation of warning tape with backfilling. Install 12 inches below grade.
Q. Minimum 48 inch bending radius.
R. Verify continuity by pulling a 12 inch mandrel ¼ inch smaller than duct diameter through each duct.
S. Maintain 5 feet clear from steam and condensate lines.
T. No less than 2 - 4 inch PVC ducts per ductbank, minimum of 1 spare duct.
U. Excavate for manholes and ductbanks far enough ahead to ensure no obstructions exist to prevent proper installation of next or connecting components.
V. Reinforcing shall be continuous into manhole wall.
W. Joints between concrete placement shall be angled.

* * * * *
SECTION 16121
MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cables.

B. Hi-Pot testing and reports.

1.2 RELATED SECTIONS

A. Section 16010: General Requirements, Electrical (Testing Requirements).

B. Section 16110: Basic Materials and Methods (Identification Requirements).

1.3 SUBMITTALS

A. Submit the following for preliminary approval:

1. Complete manufacturer's construction details and specifications for the cables, including physical and electrical characteristics of insulation, shields and jackets.

2. Overall dimension and ampacity of cable.

B. Final Approval

1. After preliminary approval, submit the following for final approval:

a. Cable manufacturer's certified test data.

b. Two-foot samples of each cable, taken from reel at job site prior to installation. Reseal cable on reel. Include the following additional information on the sample labels:

   1) The maximum voltage at which the conductor is designed to be used.

   2) Date of manufacture.

   c. Written statement from cable manufacturer indicating recommended pulling compounds.

C. Test Report: High voltage after installation test report.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Cable Delivery

1. No insulated cable over one year old when delivered to the site will be acceptable.
2. Keep ends of cables sealed at all times, except when making splices or terminations. Use heat shrinkable plastic end caps with sealant as manufactured by Raychem Corp., Thomas & Betts Co. or other methods approved by cable manufacturer.

3. Include the following data durably marked on each reel:
   a. Facility name and address.
   b. Contractor's name.
   c. Project title and number.
   d. Date of manufacture.
   e. Cable size and voltage rating.
   f. Manufacturer's name.
   g. Linear feet.
   h. Location where cable is to be installed.

B. Cable Storage: Store where cable will be at temperature recommended by cable manufacturer for optimum workability.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Okonite.

2.2 QUALITY ASSURANCE
   A. Secure and pay for the services of an approved testing company, per Paragraph 3.14, Section 16010, for a high voltage after installation test.
   B. Notify the Engineer of scheduled testing date and time so they can witness testing.

2.3 5,000 VOLT INSULATION
   A. Cable shall be type MV-90-CT USE with 133% insulation level rated 90 degrees C.
   B. Cable shall be constructed with an ethylene propylene rubber insulation and a chlorosulfonated polyethylene jacket.
   C. Cable shall be type 'OKO GUARD OKOLON" as manufactured by Okonite Company.
   D. Cable shall be factory triplexed.
   E. Shielded cable shall be used for all new construction and all replacement, where existing equipment and cable allow.

2.4 15,000 VOLT INSULATION
   A. Cable shall be type MV-90 with 133% insulation level rated 90 degrees C.
   B. Cable shall be constructed with ethylene propylene insulation and a chlorosulfonated polyethylene jacket.
C. Cable shall be type 'OKOGUARD OKOLON” as manufactured by Okonite Company or approved equal.

D. Cable shall be factory triplexed.

2.5 35,000 VOLT INSULATION

A. Cable shall be type MV-90 with 133% insulation level rated 90 degrees C.

B. Cable shall be constructed with ethylene propylene insulation.

C. Cable shall be type "OKOGUARD-OKOSEAL” as manufactured by Okonite Company or approved equal.

2.6 ACCESSORIES

A. Pulling Compounds: As recommended by cable manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installing Cables

1. Install cables in conduit after conduit system is completed.

2. Keep ends of cables sealed watertight at all times, except when making splices or terminations.

3. No grease, oil, lubricant other than approved pulling compound may be used to facilitate the pulling-in of cables.

4. Use pulling eye attached to conductor(s) for pulling in cables. Cable grip will not be allowed. Seal pulling eye attachment watertight.

5. Pull all cables with a dynamometer or strain gauge incorporated into the pulling equipment. Do not pull cables unless the Owner's Representative is present to observe readings on the dynamometer or strain gauge during the time of actual pulling. Total strain shall not exceed 1,000 pounds or manufacturer's recommendation, whichever is less.

B. Phase Relationship: Connect feeders to maintain phase relationship through system. Phase legs of feeders shall match bus arrangements in equipment to which the feeders are connected.

3.2 FIELD QUALITY CONTROL

A. High Voltage After Installation Test. See Division # 16010.

1. Perform test after cable has been installed.

2. List results of the tests on Reporting Form.

3. Perform test in the presence of the Engineer or Owner's Representative.
4. Provide copies of the test results to the Engineer.

* * * * *
SECTION 16156

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Variable frequency drives.

1.2 SUBMITTALS
A. Submit the following product data for review prior to commencing the work:
   1. Manufacturer's catalog cuts for each item, including all accessories.
   2. Additional dimensional data for each item, if not adequately covered in the catalog cuts.
   3. Verification that the proposed unit meets all quality assurance requirements specified herein.
   4. Complete installation, operation, troubleshooting, and maintenance manuals.
   5. Complete power wiring diagrams.
   6. Complete logic/control diagrams.
B. Upon completion of the installation, submit a complete list of all factory-set and field-set setpoints for record purposes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER
A. Square D

2.2 QUALITY ASSURANCE
A. Each drive shall be fully functionally tested prior to shipment from the manufacturer.
B. The drive manufacturer shall certify that the System Distortion Factor (as applied to line notching) and the harmonic distortion of voltage and current shall not exceed the limits as defined by IEEE Standard 519.

2.3 VARIABLE SPEED DRIVES, GENERAL REQUIREMENTS
A. Drives shall be mounted in minimum NEMA 12 enclosures.
B. Drives shall be of the PWM (pulse width modulation) type.
C. Internal drive control shall be fully digital and field programmable without external hardware.
D. Drives shall include a "Line/Drive/Off/Test" selector switch and a complete motor starter for the bypass mode, including short circuit protection.
E. Drives shall include a complete set of spare fuses.
F. Drives shall have an efficiency of 97 percent or greater at 100 percent speed and a power factor of 0.95 or greater.
G. Drives shall have a 1 minute overload rating of 150 percent.
H. Drives shall be capable of operating any NEMA Design B squirrel cage induction motor with a load rating equivalent to the capacity of the VFD.

2.4 OPERATIONAL REQUIREMENTS
A. Drives shall be capable of an automatic restart following a power line transient, when the power returns to normal.
B. Drives shall be capable of an automatic restart after selected faults. The number of restart attempts shall be adjustable at the drive for zero, one, or two.
C. Drives shall be suitable for use with a 4-20 mA dc or 0-10 Vdc electronic input control signal and include a 4-20mA speed feedback signal.
D. Drives shall be capable of restarting into a coasting load with re-synchronization requiring not more than 150 percent of design current. Reapplication of full accelerating torque shall require less than 2 seconds following a 1 second total loss of power.
E. Drives shall have provisions for wiring in safety controls (freezestats, fire alarm shutdowns, etc.) in both the drive and bypass modes.
F. Drives shall include the following, as a minimum:
   3. Status indicator lights for power on, running, and fault.
   4. Adjustable current limit.
   5. Adjustable acceleration and deceleration rates from 3 to 280 seconds.
G. Two normally open and two normally closed auxiliary dry contacts to indicate drive status and fault.
H. A test card or module for troubleshooting all drives in the building.

2.5 INSTRUMENTATION REQUIREMENTS
A. Drives shall include a Digital Display with the following monitored functions, as a minimum:
   1. Output frequency, voltage, and current.
   2. Elapsed time.
   3. Indication of fault type.
   4. Speed indication.

2.6 PROTECTIVE REQUIREMENTS
A. The "Drive/Line/Off/Test" selector switch shall be suitable for use as an input disconnect for both the drive and the bypass motor starter.
B. The drives shall include over current, over voltage, under voltage, phase loss, over temperature, short circuit, and ground fault protection, output current trip, and stall protection as an absolute minimum.
C. The drives shall include motor thermal protection.
2.7 ADDITIONAL REQUIREMENTS

A. Input disconnect with operating handle operable from exterior of enclosure.
B. AC input line current limiting fuses rated 200,000 AIC for fault current protection of AC to DC converter section.
C. Manual bypass starter with Inverter-Off-Bypass selector switch.
D. Line isolation contactor.
E. 5 percent input line reactor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate the drives where shown on the drawings.
B. Install the drives in strict conformance with the manufacturer’s written installation instructions.
C. Run drive supply and load side conductors in separate conduits.

3.2 DOCUMENTATION

A. At the end of commissioning, permanently affix a complete as-built wiring diagram, with all field setpoints identified, to the inside of each drive control section.

3.3 START-UP AND OWNER TRAINING

A. The drive manufacturer shall have a local service office, staffed by factory trained service engineers, within a 100 mile radius of the project site.
B. System start-up shall be performed only by a factory trained service engineer.
C. All required training of the Owner's service personnel shall be performed at the Owner's facilities.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Motor Control Centers.

1.2 REFERENCES
   A. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
   B. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.3 SUBMITTALS
   A. Shop drawings indicating plan view and front and side elevations of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends, instrument details; and electrical characteristics including voltage, amperage, withstand, interrupting, BIL, and time-current curves for all components.
   B. Instructions for handling and installation.
   C. Product data for all accessories.
   D. Weights and dimensions of shipping splits.

1.4 OPERATION, MAINTENANCE, AND TRAINING DATA
   A. Submit operation data including instructions for all programming and adjustments.
   B. Submit maintenance data including all recommended spare parts, testing, adjustment, cleaning, and inspection.
   C. Training outline.

1.5 DELIVERY, STORAGE AND HANDLING
   A. Deliver F.O.B. to site.
   B. Coordinate shipping splits and delivery schedule with Owner’s Representative.
PART 2 - PRODUCT

2.1 ACCEPTABLE MANUFACTURERS
   A. Allen-Bradley (Bulletin 2100).
   B. Square D (Model 6).

2.2 QUALITY ASSURANCE
   A. Each motor control center will go through a quality inspection before shipment. This inspection will include:
      1. Physical inspection of the structure, bussing, general wiring, and units.
      2. Electrical Tests including power circuit phasing, control circuit wiring, and device electrical operation.
      3. AC Dielectric Tests of the power circuit and control circuits.
      4. Markings/Labels, including:
         a. Instructional type,
         b. Underwriters Laboratory and inspector's stamps.

2.3 MATERIALS
   A. Each motor control center shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, freestanding assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the motor control center line-up at the top. Removable 7 gauge bottom channel sills shall be mounted front and back rear of the vertical sections extending the full width of the line-up. Vertical sections shall have structural support members formed from a minimum of 12 gauge hot rolled steel. Internal reinforcement structural parts shall be of 11 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand all stresses included in transit and during installation.

2.4 MCC FINISH
   A. All steel parts shall be provided with UL listed acrylic baked enamel paint finish, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.
   B. The standard paint finish shall be able to pass at least 300 hours of salt spray per ASTM B117 with less than 1/8 inch loss of paint from a scribed line.
   C. Paint color shall be #49 medium light gray per ANSI standard Z55.1-1967.

2.5 STRUCTURES
   A. Totally enclosed, dead-front, freestanding assemblies, capable of being bolted together to form a single assembly.
B. Minimum NEMA 12.

C. Each 20 inch wide standard section shall have all the necessary hardware and bussing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units.

D. Each section shall include a single piece top plate and a bottom plate, each removable to ease the cutting of conduit entry openings.

E. Provide a drip hood.

2.6 WIREWAYS

A. Minimum 12 inch high horizontal wireway at the top of each section and a minimum 6 inch high horizontal wireway at the bottom of each section. These wireways shall run the full length of motor control center to allow room for power and control cable to connect between units in different sections.

B. Vertical wireway shall be provided in each motor control center section that accepts modular plug-in units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 inches wide minimum with a separate hinged door. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the motor control center horizontal wireways.

2.7 BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a molded glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.

B. The vertical bus shall be housed in a modular glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 inches for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.

2.8 BUSSING

A. All bussing and connectors shall be tin plated copper or silver plated copper. Main lugs shall be copper-compression type.

B. The main horizontal bus shall be rated at 800 AMP continuous unless noted otherwise and shall extend the full length of the motor control center. Bus ratings shall be based on 65 degrees C maximum temperature rise in a 40 degree C ambient. Provisions shall be provided for splicing additional sections onto either end of the motor control center.

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack which can be easily installed into the end of the motor control center power bus to allow the installation of additional sections.
D. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus and shall be rated at 300 AMP minimum continuous. The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical-to-horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

E. A tin-plated copper ground bus shall be provided that runs the entire length of the motor control center. The ground bus shall be 0.25 inch x 1.0 inch and be rated for 300 amps. A compression lug shall be provided in the motor control center for a 4/0 ground cable. The ground bus shall be provided with six 0.38 inch holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.

F. Each vertical section shall have a vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

G. The power bus system shall be braced for a short circuit capacity of 65,000 RMS amperes minimum as standard.

2.9 UNIT CONNECTIONS

A. Units with circuit breaker disconnects through 250 amp frame shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

B. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

C. All plug-on units shall utilize a two stage ADVANCE/RETRACT type operating mechanism which will allow the unit to disengage from the power bus without withdrawing the unit from the motor control center. A nondefeatable mechanical interlock shall prevent installing or removing a plug-in unit from the structure unless the mechanism is first placed in the RETRACT position. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

D. All nonplug-on units shall utilize a fixed position type operating mechanism which allows complete “on/off” control of the unit disconnect with the clear indication of the disconnect's status. All circuit breaker operators shall include a separate “tripped” position. A mechanical interlock shall prevent an operator from opening the unit door when the disconnect is in the "on" position. Another mechanical interlock shall prevent an operator from placing the disconnect in the "on" position while the unit door is open.

E. Provisions shall be provided for locking all disconnects in the "off" position with up to three padlocks.

2.10 CIRCUIT BREAKER TYPE COMBINATION MAGNETIC MOTOR STARTERS

A. Full voltage, nonreversing, unless otherwise indicated.
B. Circuit Breaker Assemblies: Molded case circuit breaker with externally operable handle. Operating handle shall give positive visual indication of ON-OFF with a color coded operating handle.

   1. Unless otherwise indicated, connect time delay relay to delay start of motor.
   2. For dual speed starters, connect time delay relay to delay closure of low speed contacts when transferring from high speed.

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

D. Coil: 120 Volt, 60 Hz, encapsulated.

E. 3-pole unless otherwise indicated.

F. Sizes and quantities as indicated.

G. Overload Relay: Electronic, SMP-1.

H. Auxiliary Contacts: NEMA ICS 2, two each normally open and two each normally closed contacts in addition to seal-in contact unless otherwise indicated.

I. Cover Mounted Pilot Devices: NEMA ICS 2, heavy duty oiltight type.

J. Indicating Lights: Transformer type, single red "RUN" light for each unit unless otherwise indicated.

K. Selector Switches: Rotary type, "HAND - OFF - AUTO" unless otherwise indicated.

L. Time Delay Relays: 0 to 60 second adjustable for each unit.

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

N. Rated for installation in a power system capable of delivering up to 65,000 RMS symmetrical amperes.

2.11 TERMINALS

A. Type B Wiring: all starter units shall be provided with unit pull-apart type terminal blocks rated at 20 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened.

2.12 NAMEPLATES

A. Shall be engraved phenolic nameplates for each MCC and unit compartment. Shall be black background with white letters, measuring a minimum of 1.5 inch H by 6 inch W total outside dimensions.

   B. Nameplate lettering schedule shall be provided.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

   B. Verify field measurements are as shown on Drawings.
C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning in installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Adjust overload relays to suit motors served.

C. Provide services of factory-trained engineer to assist with start up, adjustment, and training.

* * * * *
PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Grounding electrodes and conductors.
B. Connections.
C. Equipment grounding conductors.
D. Bonding.

1.2 REFERENCES

1.3 GROUND ELECTRODE SYSTEM
A. Rod electrodes.
B. Ground grids.
C. Tails to specific equipment.
D. Ties to building steel.

1.4 SUBMITTALS
A. Manufacturer's data on ground rods, conductors, and connectors.
B. Samples of mechanical connectors when requesting substitute for exothermic welded connections.
C. Test report.

PART 2 – PRODUCTS

2.1 GROUNDING CONDUCTORS
A. Ground wires shall be annealed, bare or green color insulated stranded copper, with 98% conductivity. Size of wires shall be as shown on the drawings. If not shown, they shall be in accordance with the requirements of National Electrical Code.

2.2 GROUNDING ELECTRODES
A. Ground rods shall be copper, or copper-clad steel not less than 3/4 inch in diameter and 10 feet long.
2.3 BURIED CONNECTIONS

A. Exothermic weld process, designed specifically for items being connected.

2.4 ABOVE SURFACE CONNECTIONS

A. Structural Steel: Exothermic weld process, designed specifically for items being connected.

B. Equipment: Grounding lugs, connectors, and other components shall comply with the requirements of the National Electrical Code.

PART 3 – INSTALLATION

3.1 GROUND SYSTEM

A. The grounding system shall consist of embedded and exposed bare copper cables interconnected to form a grid to which all electrical equipment, building steel, and existing system grounds shall be connected.

B. The Contractor shall ground all equipment whether indicated on the drawings or not. All exposed non-current carrying metallic parts of equipment and other sizable metallic objects such as motors, electrical panels, motor control centers, conduit, and pumps shall be grounded. Underground piping, piping supports and tanks shall be grounded only if so shown on the drawings. Neutral conductors of the wiring system shall be grounded at the transformer secondaries only. The grounding connections shall be made as indicated on the drawings and as required by the National Electrical Code.

C. The use of EMT as a grounding conductor will not be acceptable. A ground wire shall be installed in EMT with power conductors to complete the grounding systems. Rigid conduit may be used as a grounding conductor as allowed by the National Electrical Code, and with approval of the Owner.

D. Equipment grounding connections shall be made by means of screw-type pressure connectors. All underground connections shall be made by exothermic welding. Ground conductors below grade shall be buried at a depth of 2 feet minimum.

E. Grounding conductor stubups exposed to mechanical damage shall be protected.

F. Where grounding conductors are run parallel to underground metallic piping, they must be at least 10 feet apart to reduce galvanic corrosion of the piping resulting from proximity of the copper cable. Grounding cables buried and crossing other buried metallic components, such as pipes, shall be not less than 5 feet from such components or the ground cable shall be insulated with plastic tape and installed in PVC conduit for 5 feet on either side of the crossing.

G. Column grounds shall be made by exothermic welding not less than 2 feet above the finished slab elevation, unless otherwise shown on the drawings.

H. Ground cables installed along beams or columns shall be run on the inside of the flange adjacent to the web where practical and shall be secured by beam clamps.

I. Where copper connectors are bolted to steel surfaces or equipment frames or enclosures, the contact surfaces shall be permanently thinned before assembly and secured with minimum 3/8 inch diameter bolts, washers and equipment frames. Such holes shall have sufficient depth for the tapped thread to extend a depth at least equal to the diameter of the bolt. Steel pads securely welded to the equipment may be added as required to provide the necessary depth for the tapped hole.
J. Bolted joints are to be used on equipment and exposed grounds. Bolted contact surfaces shall be polished bright and covered with No-Oxide or similar anti-corrode compound. After assembly, edges of joint shall be sealed with zinc chromate paint.

K. Moving equipment on rails need not be separately grounded if the rails that support the equipment are grounded.

L. All electrical substations/switchgear shall be effectively grounded to the station ground. The use of conduit connections to equipment for grounding will not be accepted as satisfying the grounding. All equipment ground connections shall be clearly visible.

M. The non-current carrying housing of portable equipment shall be connected to the ground system by means of a grounding conductor the size of which shall conform to the requirements of the National Electrical Code.

3.2 QUALITY CONTROL AND TEST

A. Ground rods shall be buried full length into the earth. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. Following the installation, the ground rods shall be tested as specified in paragraph 3.14 of Section 16010. If the resistance exceeds 25 ohms measured not less than 48 hours after rainfall, additional ground rods shall be installed as directed by the Engineer to meet the required maximum resistance value.

B. Submit written test report including resultant ground resistance values, temperature, humidity, and condition of the soil at the time of the test.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Engine generator system consisting of diesel engine-generator, weatherproof and sound attenuating housing, critical class exhaust silencers, self-contained cooling systems, panel for unit accessories, local and remote controls, base-mounted fuel tank, and accessories as indicated or required.

B. Pad and appurtenances.

C. Delivery to site.

D. Factory and field testing.

E. Installation, check-out, start-up, and instruction period for Owner's personnel.

1.2 REFERENCES

A. ANSI, DEMA, NEMA, ASME, NFPA, OSHA.

B. UL Standards 891 or 1558 - for listing and labeling.

C. UL 2200 – Stationary engine generator assemblies.

1.3 SUBMITTALS

A. Manufacturer's data for all equipment.

B. Manufacturer's installation instructions for all equipment.

C. Complete shop drawings showing layout, elevations, and all required interconnections including schematic and wiring diagrams.

D. Upon Delivery

1. As-built drawings.

2. Six (6) complete sets of instruction manuals, including functional descriptions, block diagrams, safety precautions, and step-by-step operating and maintenance procedures, including illustrations and troubleshooting guide.

3. Updated list of available and recommended spare parts.

E. Two (2) weeks prior to training session:

1. Training outline (6 copies).

2. Any additional technical data not delivered above, to be used in training (6 copies).
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Cummins Onan (Preferred).
B. Caterpillar (Subject to written approval).
C. Kohler (Subject to written approval).

2.2 QUALITY ASSURANCE
A. Except as specified herein, material and equipment to be supplied shall be standard cataloged product of a manufacturer regularly engaged in the manufacture of diesel engine generator systems with 10 years experience and shall be latest standard design conforming to the specifications requirements.
B. Supplier shall be factory authorized dealer/installer with at least 3 years documented experience.

2.3 UNIT PERFORMANCE
A. One Step Load Acceptance: 100 percent of nameplate KW rating at 0.8 PF. Meet requirements of NFPA 110 Paragraph 5-13.2.6.
B. Voltage Recovery After Acceptance of 100 Percent of Rated Load in One Step: 5.50 seconds.
C. Voltage regulation under varying loads from 0 to 100 percent load ±1 percent maximum.
D. Random Voltage Variation: Will not exceed ±1 percent of its mean value for constant loads from no load to full load.
E. Frequency regulation isochronous, no load to full load.
F. Random Frequency Variation: Not to exceed ±0.25 percent of its mean value for constant loads from no load to full load.
G. Total harmonic content of the AC waveform is less than 5 percent.
H. Telephone Influence Factor (TIF): Less than 50 per NEMA MG1-22.43.
I. Alternator Temperature Rise: 125 degrees C at standby rating at rated load.
J. Waveform Deviation Factor: Less than 0.06 line-to-line.
K. Not susceptible to SCR or transistor starter UPS loads and undesirable transients therefrom.

2.4 ENGINE
A. Diesel, water-cooled, turbocharged, and aftercooled.
B. Unit mounted pumps and auxiliaries shall be engine driven.
C. Capable of driving the generator to provide specified unit ratings and performance.
D. Maintenance and service items such as filters, etc., shall not require disassembly of piping and other major pieces of the engine.

E. Positive displacement engine driven fuel pump.

F. Electronic governor capable of maintaining isochronous alternator frequency from no-load to full load output. Speed Droop Adjustability: 5 percent.

G. Battery electric starting system including battery charging alternator with transistorized voltage regulator, solenoid shift-electric starter, storage batteries with all connectors; mounting rack and sufficient capacity for four 20 second cranking cycles at 30 second intervals. Separate minimum battery charger, shall be solid state, with automatic fast and trickle charging, capable of recharging batteries to full potential within one hour after a cranking cycle, suitable for wall mounting, 120V A.C. input and equipped with an ammeter, etc.

H. Inlet and outlet flexible connections for cooling system, exhaust piping and for fuel lines.

I. Engine protective devices shall include an alarm circuit and/or shutdown for low engine temperature, overvoltage, overcrank, overspeed plus pre-shutdown or shutdown for high coolant temperature and low oil pressure.

J. Pressure type lubricating system with gear type oil pump and full flow filter shall be fitted to the engine.

K. Other items shall include engine driven jacket water circulating pump and thermostatically controlled pre-wired jacket water heater, battery heater, and heaters as required for engine accessories.

2.5 VIBRATION ISOLATION

A. Engine-generator sets shall be supported on vibration isolators and flexible connections provided for pipes and ducts to be connected to the sets.

2.6 COOLING SYSTEM

A. Engine mounted, with direct drive fan.

B. Liquid Coolant: 50 percent glycol mixture.

2.7 AIR INTAKE AND EXHAUST SYSTEM

A. Air intake cleaner shall be induction type with dry-type elements.

B. Air exhaust silencer shall be critical type, equipped with expansion bellows and designed for minimum back pressure.

2.8 GENERATOR (ALTERNATOR)

A. Design: Revolving field, 4-pole, brushless, minimum reactance, low voltage waveform distortion and efficiency.

B. Rotor: Amortisseur windings, dynamically balanced, permanently aligned to engine by flexible disc coupling.

C. Exciter: PMG type.
D. Voltage Regulator: Solid state, temperature compensated zener diode, silicon controlled rectifiers with phase controlled sensing circuit providing automatic voltage reduction if load exceeds engine capacity; also prevents overheating or blowing of fuses in load circuits due to saturation of magnetic components.

E. Insulation: Class H per NEMA MG1-1.65.

F. Ball Bearing: Heavy duty, prelubricated cartridge design (extra large lubricant reservoir).

G. Cooling: Direct drive centrifugal blower.

2.9 ENGINE-GENERATOR CONTROLS

A. Engine Controls

1. Run-Stop-Remote switch.
3. Oil pressure gauge.
4. Coolant temperature gauge.
5. Battery charge rate ammeter.

B. AC Output Controls Include

1. AC voltmeter.
2. AC ammeter.
4. Voltage adjusting rheostat.
5. Frequency meter.
6. Running time meter.
8. Speed control potentiometer.

C. Status indicating lamps with signal circuits for connection to a remote alarm annunciator.

1. Low coolant temperature.
2. Prewarning and shutdown for high coolant temperature.
3. Prewarning and shutdown for low oil pressure.
4. Shutdown for overvoltage (AC output).
5. Overcrank.
6. Overspeed.

D. Signal circuits for connection to a remote alarm annunciator (lamp on annunciator).

1. High battery voltage.
2. Low battery voltage.
3. Generating (ready to load).

E. Control and Diagnostic Circuits

1. Cycle cranker (crank, rest, recrank sequence).
2. Crank and run lamp.
3. Overspeed magnetic sensor lamp.
4. Start and stop adjustable time delays.
5. Common alarm terminal.
F. Enclosure, mounted on generator end contains all devices required to perform specified and required functions. The control box shall include section for the engine-generator set controls and provisions for cable terminations.

G. Alarm to sound whenever an alarm light is lit and an acknowledge switch to silence alarm. Alarm and switch mounted on remote monitor panel. Lights to flash initially, steady after acknowledgement and go out after being reset.

H. Contacts for remote indications of all the preliminary alarms and engine shutdown.

I. Generator voltage regulator, three phase sensing, capable of 300% rated output for 10 seconds and have volts per hertz response.

J. Engine Control Selector Switch, "REMOTE OFF RUN" for automatic start-stop from transfer switch; manual engine start-up and shutdown.

K. Relay to start engine upon receiving signals from transfer switch.

L. Remote monitor panel with lights and alarms to provide functions described above.

2.10 ENCLOSURE (WEATHER PROTECTIVE, LOCKABLE)

A. All weather louvers and grilles for airflow required for operating the E/G set.

B. Heavy gauge steel construction reinforced sheet steel, attached to the sets mounting base and radiator cowling.

C. Removable panels on each side for E/G access. Hinged door for control panel access.

D. Shipped fully assembled to unit.

E. Equipped with lining and hoods as required to affect a 15 to 20 dB noise reduction.

2.11 ENCLOSURE POWER LOAD CENTER

A. 120/208 volts 1 phase 3 wire, circuits as needed.

B. Branch Circuit Breakers: As required.

C. Shipped fully assembled to unit.

2.12 SERVICE TANK

A. Double-wall construction.

B. Leak monitoring with alarm indication at generator control panel and remote monitor panel.

C. Capacity to operate generator at full load for 24 hours.

D. Including tank heating system or in-line fuel heater.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in strict accordance with manufacturer's instructions.

3.2 FACTORY AND FIELD TESTS/REPORTS

A. All tests shall be followed up, within ten days in each case, with written test reports for Owner and their representatives' review and acceptance.

B. Five (5) working days advance notice of testing shall be given to the Owner and their representatives to allow them to witness the tests.

C. Include all costs of all tests.

D. Factory Tests

1. Factory testing at rated load and power factor, in the presence of Owner and their Representatives, for at least 4 hours. The following parameters shall be read and recorded at 15 minute intervals throughout the test:

   a. Engine oil pressure and temperature.
   b. Engine exhaust temperature at exhaust manifold.
   c. Jacket water temperature at inlet and outlet.
   d. Engine RPM.
   e. Fuel pressure.
   f. Ambient air temperature.
   g. Three phase voltages and currents.

2. Check functioning of the high-temperature coolant circuit safety device by restricting cooling system capability.

3. Check with a light overspeed shutdown device operation. Record speed at which overspeed trip operates; must be set to operate at no more than a 10 percent overspeed condition.

4. Check engine-generator sets also for the following:

   a. Low oil pressure protective device test.

5. Rated load for the purpose of these factory tests would mean:

   a. The specified ratings at sea level and 85 degrees F ambient.
   b. The test loads having 0.8 power factor.
   c. Transient response test shall be done at 25 percent, 50 percent, 75 percent and 100 percent of the rated load and record voltage and current transient responses on high speed chart recorder.
3.3 FIELD SERVICE
   A. Provide a minimum of three working days that may be split in two two-day trips plus travel time, etc., for assisting Contractor in installation check out, start-up, instruction period for Owner's personnel and field tests.

3.4 FIELD TESTS/REPORTS
   A. Field tests are to be done at full load, with the use of building loads and auxiliary resistive load banks if required.
   B. E/G field tests shall be done in conjunction with the automatic transfer control system functional requirements.
   C. Field test shall be coordinated with and performed in cooperation with the Installing Contractor and the Owner.

3.5 TRAINING
   A. Provide a minimum of 4 hours on-site training by factory-trained Engineers, to acquaint the Owner's Representatives with the proper adjustment, operation, and maintenance of the equipment.
   B. Assume a class size of up to 6 personnel.
   C. Coordinate the training schedule to be within 1 week of final acceptance of the energized equipment.

3.6 WARRANTY
   A. One year from start-up, covering all costs of repairs or adjustments.

3.7 EXTENDED WARRANTY
   A. An additional 24-month complete warranty and maintenance agreement for the generator and for the transfer switch as an option in the quotation. Detail preventative maintenance visits proposed and any costs deemed to be outside the proposed agreement.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Panelboards.
B. Circuit breakers.
C. Disconnects.
D. Fuses.

1.2 REFERENCES

A. NEMA AB1 - Molded Case Circuit Breakers.
B. NEMA KS1 - Enclosed Switches.
C. NEMA PB1 - Panelboards.
D. NEMA PB1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
E. ANSI/UL 198C - High Interrupting Capacity Fuses; Current Limiting Types.
F. ANSI/UL 198E - Class R Fuses.

1.3 SUBMITTALS

A. Panelboards: Shop drawings and product data.
B. Circuit Breakers: Product data, typical test reports.
C. Disconnects: Product data.
D. Fuses: Product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Panelboards: Square D, Cutler Hammer.
B. Circuit Breakers: Square D, Cutler Hammer.
C. Disconnects: Square D, Cutler Hammer.
D. Fuses: Bussman.

2.2 PANELBOARDS

A. General

1. Panelboards shall be surface or flush mounted as shown on the drawings and shall be dead-front, consisting of an enclosure, a removable interior unit, and a removable front cover with door.

2. The panelboards shall be provided with main circuit breakers and number of breakers as shown on the drawings.

3. The panelboard enclosures shall be NEMA Type 12 unless otherwise indicated on the drawings and shall conform to UL Standard UL-50.

4. Enclosures for outdoor installation shall be NEMA Type 3R, fabricated from extra heavy gauge sheet steel, hot-dipped galvanized after fabrication and provided with doors and drip shield.

5. Enclosures shall be provided with hinged cover and lock.

6. All locks shall be keyed alike.

7. Fronts shall be furnished with adjustable trim clamps for securing the front to the box.

8. Size of breakers and rating of main lugs shall be as indicated.

9. Panels shall be for operation on voltage, number of phases, and number of wires shown on the drawings.

10. Multipole circuit breakers shall be the common trip type with a single operating handle.

11. Each panelboard shall be equipped with a full capacity isolated neutral bus and a bonded equipment bus, unless otherwise specified on the drawings.

B. 120/208/240 Panelboards

1. All Lighting and Appliance branch circuit panelboards with more than twelve (12) circuits shall by type "POW-R-LINE C", as manufactured by Cutler Hammer, or approved equal.

2. Bus Bars shall be copper.

3. Branch breakers shall be plug-in type.

4. Panels must accept Cutler Hammer/Westinghouse type "HQP" breakers.

C. 120/208/240 Load Centers

1. Lighting and Appliance branch circuit panelboards with twelve (12) or less circuits, may be "commercial rated load centers", as manufactured by Cutler Hammer, or approved equal.

2. Branch breakers shall be plug-in type.

3. Panels must accept Cutler Hammer/Westinghouse type "HQP" breakers.
D. 277 Volt Lighting Panelboards

1. Circuit breaker panelboards used for 277 volt lighting shall be type NEHB as manufactured by **Square D** (no substitution).

2. Panelboard to have all copper bus.

3. Panelboard to have integrated equipment short circuit rating of 65,000 amperes RMS Symmetrical.

E. Distribution

1. Panelboards shall be **Square D** type HCM-I-Line (no substitution) with plug-on branch breakers.

2. Fronts shall be hinged to box whenever box height is 60” or greater.

3. In addition to the directory, a 1/2 inch high plastic embossed self sticking tape shall be attached next to each branch breaker identifying the breaker function.

4. Bus Bars shall be copper.

F. Directory Holder

1. A directory holder with protective covering shall be provided on the inside of each door and completely labeled by the Contractor.

2. The directory shall be typed.

3. Hand-lettering or marking is not acceptable.

G. Panelboard Schedules

1. Where panelboard schedules are provided, they shall be used by the contractor as a guide for circuitry, phase balancing, and ordering of panelboards.

H. Spare Breakers

1. Each panel shall be provided with a minimum of 25% spare breakers, whether shown on drawing or schedule, proportioned in number to the size or sizes of breakers being used for each frame size.

I. Spaces

1. Each panel shall be provided with a minimum of 25% spaces, whether shown on drawing or schedule.

2. Spaces shall include all necessary bus and accessories, ready to accommodate future breakers.

3. All spaces shall include blank cover.

2.3 CIRCUIT BREAKERS

A. Quick-make, quick-break molded-case circuit breakers, manually operated.
B. Thermal/magnetic indicating type common trips.

C. Shunt trips and other auxiliaries where applicable or indicated.

D. Interrupting rating for circuit breakers in 120/208 volt panels shall be not less than 10,000 amperes RMS Symmetrical.

E. Interrupting rating for circuit breakers in 277/480-volt panels shall be not less than 14,000 amperes RMS symmetrical.

F. Ground fault protection, as scheduled or indicated.

G. Voltage and ampacities, as scheduled or indicated.

H. Circuit breakers shall conform to NEMA Standard AB-1.

I. All 15 and 20 ampere single pole breakers shall be SWD rated.

2.4 DISCONNECTS

A. Fused or unfused ampacities and number of poles, as scheduled, indicated or required.

B. Surface mounted, heavy duty, single throw.

C. Horsepower rated.

D. Positive quick-make, quick-break operating mechanism.

E. Interlocked door and operating handle padlockable in "OFF" position.

F. NEMA 12 enclosures for interior applications, NEMA-3R for exterior applications.

2.5 FUSES

A. UL Class L Fuses: Time delay, highly current limiting use in bolted pressure and high pressure contact switches. 200,000 AIC. Bussman low-peak, or as approved.

B. ANSI/UL Class RK5 Fuses: Time delay, for all applications not specified or indicated otherwise. 200,000 AIC. Bussman Fustron, or as approved.

PART 3 - EXECUTION

3.1 PANELBOARDS

A. Panelboards shall be installed as shown on the drawings and in accordance with the manufacturer's installation instructions.

B. For flush mounted panelboards, stub extra conduits (25 percent of actual used but not less than 4 each) for future branch circuits. Where conduits are stubbed from the top and bottom of the same panelboard, conduit ends - either top or bottom, shall be capped.

C. Panelboards shall be mounted so that the height of the top operating handle will not exceed 6 feet from the floor.
D. Ground panelboard enclosure and ground bus.

E. Directories shall be type-written to indicate load served by each circuit and shall be mounted in holder behind protective covering.

3.2 CIRCUIT BREAKERS

A. Group mounted in panelboards or individually mounted in circuit breaker enclosure.

B. Ground circuit breaker enclosures.

3.3 DISCONNECTS

A. Wall mounted at locations indicated.

B. Ground disconnect enclosures.

3.4 FUSES

A. Install in fuse holders so that the ratings are visible from the front.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Unit substation.
   B. Training for Owner's Representatives.

1.2 REFERENCES
   B. ANSI/IEEE C57.10 - Power Transformers.
   D. NEMA 210 - Secondary Unit Substations.
   E. ANSI/IEEE C62.41 - Category A Environments.

1.3 SUBMITTALS
   A. Shop drawings indicating plan view and front and side elevations of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends, instrument details; and electrical characteristics including voltage, amperage, withstand, interrupting, BIL, and time-current curves for all components.
   B. Instructions for handling and installation.
   C. Product data for all accessories.
   D. Weights and dimensions of shipping splits.
   E. Operation data including instructions for all tap and circuit breaker adjustments.
   F. Maintenance data including all recommended testing, adjustment, cleaning, and inspection.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Deliver F.O.B. to site.
   B. Coordinate shipping splits and delivery schedule with Owner.
2.1 ACCEPTABLE MANUFACTURERS
   A. Square-D., Westinghouse, Cutler Hammer, or ABB.

2.2 QUALITY ASSURANCE
   A. Except where specified otherwise, all systems, components, and subassemblies shall be standard cataloged products of the manufacturer listed.

2.3 GENERAL
   A. Description: Secondary unit substation manufactured to NEMA 210 and applicable ANSI/IEEE standards, self-supporting structures.
   B. Service Conditions
      1. Temperature: 104 degrees F, 40 degrees C.
      2. Altitude: 1,000 feet.
      3. Location: As indicated.
   C. Configuration: As indicated.
   D. Doors and Access Panels: Hinged and bolted with captive nuts. If operating handle provided, include 2 point roller latch assembly (3 point if larger than 20 inch by 60 inch).
   E. Paint: Manufacturer's standard.
   F. Hardware: Stainless steel.
   G. Continuous plated copper ground bus through all sections.
   H. All sections to have integral provisions for lifting, skidding, or jacking.

2.4 INCOMING SECTIONS
   A. Description: As indicated.
   B. Configuration: As indicated.
   C. System Voltage: As indicated.
   D. Design Voltage: As indicated.
   E. BIL: As indicated.
   F. Continuous Rating: 600 amperes.
   G. Current Limiting Fuses: Include 3 spares, sizes to be determined (400 amperes or smaller).
   H. Withstand: 40,000 amperes.
I. Plated copper terminals for 2 sets of cable up to 500 kcmil.
J. Plated copper ground terminal for conductor up to 250 kcmil.
K. Intermediate class, MOV design lightning arrestors rated as indicated.
L. Fuse section barriered from switch section and access to both interlocked to switch operation.
M. Kirk key interlocked with secondary main circuit breaker to prevent energizing transformer under load.
N. Padlockable in off position only.

2.5 TRANSFORMER SECTION

A. Description: Epoxy resin cast coils, both primary and secondary. Copper windings. All primary and secondary connections to be copper.
B. Capacity: As indicated.
C. Voltage: As indicated.
D. BIL: As indicated.
E. Taps: 2 - 2.5 percent above and below normal.
F. Impedance: 5.75 percent nominal.
G. Temperature Rise: 220 degree C insulation with 80 degree C rise over 30 degree C average temperature.
H. Noise Rating: As indicated.
I. Fan Cooling System: Includes 120 VAC fans, temperature monitor, and alarm with provisions for remote monitoring of temperature, alarm status, and fan on/off status; and all power supplies, controls, and mountings.

2.6 SECONDARY SECTION

A. Description: Switchboard manufactured to NEMA PB2 and applicable ANSI/IEEE standards.
B. Bus: Copper, sized for maximum forced air rating of transformer. 65,000 ampere bracing.
C. Bus Connections
   1. Copper to Copper: Bolted, silver plated.
D. Circuit Breakers
   1. General
      a. Dead front, draw out, stored energy, manual operated, power style.
      b. Static trip with long time, short time, and instantaneous trips.
      c. Provisions for testing trips in place without removing wiring.
      d. Individually padlockable in the off position.
      e. 65,000 AIC.
2. Main Breaker
   a. Sized for maximum forced air rating of transformer.
   b. Kirk Key interlocked with primary switch.

3. Feeder Breakers
   a. Ratings as indicated.
   b. With individual miniature ammeter and current transformers, meters mounted in door.
   c. Burndy type YA (or equal) lugs. Quantities: As scheduled.
   d. Spaces to be fully bussed and equipped.
   e. Quantities: As indicated.

E. Integrated, fully electronic metering unit complete with required current transformers, voltage transformers, and accessories.

1. Electro Industries (Futura Plus™) (no substitutions).

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that surfaces are ready to receive work.
   B. Verify field measurements are as shown on Drawings.
   C. Verify that required utilities are available, in proper location, and ready for use.
   D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.

3.3 FIELD QUALITY CONTROL
   A. Test as per Section 16010.

3.4 ADJUSTING
   A. Adjust transformer taps to provide acceptable voltage at utilization equipment connected to substation.
   B. Adjust trip units to provide adequate overcurrent protection and selective tripping with upstream and downstream protective devices.
   C. Employ Manufacturer’s Representative to ensure proper startup and adjustment.
3.5 INSTRUCTION

A. Employ Manufacturer’s Representative to instruct Owner’s Representative in maintenance and operation.

* * * * *
SECTION 16460
DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Dry-type transformers.

1.2 REFERENCES
A. ANSI/NEMA-ST1 - Specialty Transformers.
B. ANSI/NEMA-ST20 - Dry-Type Transformers for General Applications.

1.3 SUBMITTALS
A. Product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Square D.
B. Cutler Hammeroval.
C. General Electric.
D. Jefferson.

2.2 QUALITY ASSURANCE
A. Standard cataloged units of manufacturers listed.

2.3 DRY-TYPE TRANSFORMERS
A. General purpose dry-type, indoor enclosures.
B. Double winding.
C. Electrostatic shield winding where indicated.
D. NEMA taps, two 2-1/2 percent below and two 2-1/2 percent above.
E. Sound Levels:

<table>
<thead>
<tr>
<th>Transformer Rating</th>
<th>Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 9 KVA</td>
<td>37 dB</td>
</tr>
<tr>
<td>10 – 30 KVA</td>
<td>41 dB</td>
</tr>
<tr>
<td>31 – 112-1/2 KVA</td>
<td>45 dB</td>
</tr>
</tbody>
</table>

F. 150 degrees C temperature rise rating and Class 220 insulation.

G. Energy efficient, NEMA TP1 compliant.

H. Refer to drawings for individual transformer ratings.

PART 3 - EXECUTION

3.1 DRY-TYPE TRANSFORMERS

A. Install at locations indicated.

B. Floor mounted, provide 3 inch housekeeping pad and manufacturer recommended anchor bolts, with adequate working and ventilation clearances.

C. Install transformers with sound levels greater than 45 dB on resilient vibration-isolating mountings to prevent amplification of sound.

D. Ground transformer enclosures, secondary neutrals, and shielding.

E. Adjust winding taps to insure proper voltage at end use points.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

   A. Specification includes the design, fabrication, delivery, testing, warranty, and installation of indoor feeder and plug-in busway.

1.2 REFERENCES

   A. NEMA BU 1-94 – Busways.

   B. NEMA KS 1-96 – Enclosed and distribution equipment switches.

   C. NEMA AB 1-93 – Molded case circuit breakers and molded case switches.

1.3 SUBMITTALS

   A. Shop Drawings

      1. Shop drawings shall include all dimensions and views and shall be coordinated with structures, piping, ductwork, and lighting.

   B. Instruction Manuals

      1. Contractor shall furnish to the Owner five complete bound copies of instruction manuals for the equipment.

      2. Instruction manuals shall cover specific equipment to be supplied.

      3. Instruction manuals shall cover, at a minimum, the following points:

         a. Installation Requirement (environmental and mechanical).
         b. Operating Instructions.
         c. Maintenance Instructions.
         d. Trouble Shooting Instructions.

   C. Factory Tests and Test Reports

      1. All equipment and components shall be thoroughly tested in the vendor's shop prior to shipment.

   D. Tests shall be in conformance with referenced standards and shall also include such additional tests as are necessary to demonstrate complete compliance to all the requirements of this specification.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Square-D.

2.2 QUALITY ASSURANCE
   A. All equipment and components shall be standard cataloged items.

2.3 FEEDER BUS (VOLTAGE, PHASE, WIRE, AND AMPERAGE RATINGS AS INDICATED)
   A. Housing: Nonventilated, steel, enamel finish.
   B. Joints: Single bolt.
   C. Temperature Rise: 55 degrees C.
   D. Bus: Copper (100 percent neutral, 50 percent ground).

2.4 PLUG-IN BUS (VOLTAGE, PHASE, WIRE, AND AMPERAGE RATINGS AS INDICATED)
   A. Housing: Nonventilated, steel, enamel finish.
   B. Joints: Single bolt.
   C. Temperature Rise: 55 degrees C.
   D. Bus: Copper (100 percent neutral, 50 percent ground).
   E. Plug-in opening 24 inches on center.
   F. Covers for unused openings.

2.5 PLUG-IN DEVICES
   A. Fusible Switches (Subject to Written Approval) (Voltage, Phase, Wire, and Amperage Ratings as Indicated)
      1. Heavy duty.
      2. Rejection type fuse clips.
      3. Hookstick operated.
      4. Lockable.
      5. Mechanically interlocked cover.
   B. Circuit Breakers (Preferred) (Voltage, Phase, Wire, and Amperage Ratings as Indicated)
      1. Molded case.
      2. Hookstick operated.
      3. Lockable.
      4. Mechanically interlocked cover.
      5. Minimum interrupting capacity rating of 14KA, unless otherwise indicated.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated in accordance with manufacturers instructions and closely coordinated with structure, piping, ductwork, and lighting.

B. Support shall be independent of supports for other equipment.

C. Provide expansion fittings, firestop fittings, and weatherproof fittings where appropriate.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Automatic transfer switches.

1.2 REFERENCES
A. NEMA ICS 1 - General Standards for Industrial Control and Systems.
B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
C. UL 1008 - Standard for Automatic Transfer Switches.

1.3 SUBMITTALS
A. Submit product data and shop drawings.
B. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA
A. Include instructions for operating equipment.
B. Include instructions for operating equipment when engine generator is running.
C. Identify operating limits which may result in hazardous or unsafe conditions.
D. Document ratings of equipment and each major component.
E. Include routine preventive maintenance and lubrication schedule.
F. List special tools, maintenance materials, and replacement parts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Cummins Onan (Preferred).
B. Caterpillar (Subject to written approval).
C. Kohler (Subject to written approval).
2.2 QUALITY ASSURANCE
A. Company specializing in automatic transfer equipment with a minimum of 10 years' experience.

2.3 AUTOMATIC TRANSFER SWITCHES
A. Description: NEMA ICS 2; automatic transfer switch.
B. Configuration: Electrically-operated, mechanically-held transfer switch.

2.4 SERVICE CONDITIONS
A. Service Conditions: NEMA ICS 1.
B. Temperature: 105 degrees F.
C. Altitude: Sea level.

2.5 AUTOMATIC SEQUENCE OF OPERATION
A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
B. Time Delay to Start Alternate Source Engine Generator: 0 to 15 seconds, adjustable.
C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
D. Time Delay Before Transfer to Alternate Power Source: 0 to 120 seconds, adjustable.
E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
G. Time Delay Before Engine Shut Down: 0 to 10 minutes, adjustable, of unloaded operation.
H. Program Transition: 0 to 60 seconds, adjustable during retransfer, or in-phase monitor for retransfer.

2.6 ENCLOSURE
A. Enclosure: As indicated.

2.7 ACCESSORIES
A. Indicating Lights: Mount in cover of enclosure to indicate normal source available, alternate source available, switch position.
B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

D. Transfer Switch Auxiliary Contacts: 2 normally open, 2 normally closed.

E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.

F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal voltage.

G. Exercise Timer: Programmable for weekly or monthly testing, load or no load.

PART 3 - EXECUTION

3.1 Transfer switch shall be mounted on the Genset skid as part of the factory package.

3.2 Install and test in accordance with manufacturer’s instructions, and in conjunction with engine-generator testing.

3.3 Provide training for Owner's personnel in operation of the unit in conjunction with the engine generator.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior lighting fixtures.
B. Emergency lighting systems.
C. Exterior lighting systems.
D. Switching.
E. Exit lighting.
F. Occupancy sensing.

1.2 SUBMITTALS

A. Provide manufacturers’ product data, dimensional and mounting data and photometrics for all fixtures in one submittal.
B. Include any details for proposed special mounting required.
C. Finish of each fixture shall be noted in submittal as specified in schedule or as selected by Architect.
D. Provide E.T.L. or I.T.L. certified photometric data showing candle power distribution, lumen efficiency, maximum and average brightness, utilization coefficients data.
E. Coordinate with Architectural drawings and specifications for applicable fire ratings and ceiling types prior to preparing fixture submittals.
F. Submit catalog cuts of lamps and ballasts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Interior Office: Lithonia.
B. Exterior Flood: Rudd.
C. Exterior Wall Mount: Rudd.
D. Emergency and Exit: Emergilite.
E. Occupancy Sensors: Sensor Switch.
2.2 LIGHTING FIXTURES

A. General

Lighting fixtures shall be of type indicated on the drawings. The lighting fixtures shall be complete with necessary hangers and miscellaneous materials required. All lighting fixtures shall be grounded with an equipment grounding conductor. All high bay fixtures shall be installed with safety chain attached to building steel and the fixture.

B. Accessories

Accessories, such as plaster rings, straps, mounting plates, nipples, or brackets shall be provided for proper installation and shall be installed in such a manner as to adequately support the fixture. Guards shall be provided and installed on all high bay units and on those subject to possible mechanical damage. Enclosing lens, guards, or cover glass assemblies shall be provided with hinges to facilitate access to the lamp. Vapor-tight units having molded threaded globes for lamp access, shall be provided with durable seating gaskets for the globes. High and low bay fixtures shall have a factory supplied hanger receptacle and cord.

C. Diffuser Materials

Polystyrene or Polycarbonate diffusers shall not be permitted. Acrylic injection molded diffusers shall be used, unless otherwise specified.

D. All Exterior Floodlight H.I.D. fixtures shall be manufactured by RUDD.

E. All exterior wall mount H.I.D. fixtures shall be manufactured by RUDD.

F. All interior office fixtures shall be 2" x 4" Lithonia Optimax 3 lamp fixture with (2) electronic ballast (less than 10 percent THD) center lamp switched separate outer lamps switched separate and 3-T8 lamps factory installed. Lithonia Catalog No. PMOGH 3 32 27LS 120 GEB10 LPSP35. (Change 120 to 277 for 277V system.) Note: For surface mounted fixtures use Lithonia Catalog No. 2PMOX 3 32 27LS 120 GEB10 LPSP35.

2.3 ELECTRONIC BALLASTS (ADVANCE, OR APPROVED EQUAL)

A. UL listed.

B. Single lamp, two lamp, or three lamp parallel design, compatible with the lamp, fixture, and switching arrangement indicated. Three lamp fixtures in areas where multiple switching is indicated shall be provided with 1 one lamp ballast and 2-two lamp ballasts in each fixture.

C. High power factor, 0.9 or higher.

D. Class "P" with internal, self-resetting thermal protector. Surge and transient protected to 6,000 volt.

E. Voltage ratings as noted in fixture schedule or as required. Ballast shall operate at rated voltage plus or minus 10 percent.

F. With "A" sound rating.

G. Operate the lamps at a frequency of 20 to 35 kHz and have no detectable flicker.

H. Mounted for optimum heat dissipation.
I. Comply with FCC and NEMA limits for EMI and RFI and not interfere with the operation of other electrical equipment.

J. Manufacturer shall have been producing ballasts for a minimum of 10 years.

K. Will operate all manufacturer's lamps.

L. Less than 10 percent total harmonic distortion.

2.4 CORE AND COIL BALLASTS (only as replacement) (Advance, or equal).

A. UL listed and ETL-CBM certified and energy saving type.

B. Two lamp series or single lamp, as required, and compatible with the type of lamp and fixture for which the ballasts are used.

C. High power factor or constant wattage as applicable. The crest factor, where applicable, shall be 1.7 or less.

D. Class P internal self-resetting thermal protector where applicable. External fusing for all ballasts that are not Class “P” and rated 100 Ws or more.

E. Voltage rating as noted in light fixture schedule, or as applicable.

F. With "A" sound rating.

G. Special dimming ballasts and/or electronic packages for fixtures with dimming function.

H. Mounted for maximum effective heat dissipation.

I. Exterior ballasts shall be of weatherproof construction.

2.5 HIGH INTENSITY DISCHARGE BALLASTS

A. H.I.D. Ballasts shall be of the Regulating High Power Factor type rated to start the lamp at –20 degree F.

2.6 LAMPS

A. All fixtures shall be furnished complete with new lamps of wattage, style, type and quantity designated, at completion of the contract and include 10 percent spare lamps for Owner's use. Fixtures used for temporary lighting shall be relamped at the time of final acceptance, if hours of such use is more than 10 percent of the published lamp life.

B. All lamps shall be of latest manufacture and delivered in unopened cartons to the job site.

C. Incandescent lamps shall be inside frosted, 125 volt medium base, extended service type, where applicable, and of the wattages noted in fixture schedules or drawings. Type R or PAR, spot or flood, shall be as required, for specific fixtures. Other special lamps shall be as specified.

D. Fluorescent lamps shall be energy saving type, T-8, 3500 degree K, rapid start or high output, extended service type, where applicable, and of the wattages noted in fixture schedules or drawings. Other special lamps shall be as specified.
E. **H.I.D. Lamps:** Metal halide-phosphor coated, and high pressure sodium. Maximum available lumen output, mounting positions and wattages as applicable. The design of HPS lamps (used outdoors) shall include an amalgam reservoir external to the arc tube and include protection against vibrations. The design of metal halide lamps (used indoors) shall be of the safety, self-extinguishing type. Clear lamps, if so indicated or required for special applications.

### 2.7 EMERGENCY AND EXIT LIGHT UNITS

A. The emergency lighting unit shall consist of battery, battery charger, switching circuit, and halogen lamps. Batteries shall be 12 volt type lead calcium. Units shall be manufactured by "**Emergi-lite**".

B. Remote lights shall be complete with halogen lamps.

C. Exit lights shall be singled faced, or doubled faced with red letters and chevrons as shown on the drawings. Exit lights shall be normal powered 120/277 volt with 12 volt D.C. lamps wired to the nearest emergency lighting unit or a self-contained emergency power unit with lead calcium battery, battery charger, and switching circuit. Normal powered lamps shall be Light Emitting Diodes (LEDs).

### 2.8 CEILING MOUNT OCCUPANCY SENSORS

A. Ceiling mounted motion sensor passive dual technology sensor (motion and noise). **Sensor Switch** Inc. catalog No. PDT-CM (Sensor). Locate 2-pole 20A relay near sensor catalog No. CU-20-2P.

### 2.9 WALL MOUNT OCCUPANCY SENSORS

A. Wall mounted motion sensor with auto-off-on switch. **Sensor Switch** Inc. catalog No. WS-170D. Sensor Switch Inc. telephone number (203) 265-2842.

### PART 3 - EXECUTION

#### 3.1 LIGHT FIXTURES

A. Locations shall be as indicated on drawings with symmetrical layouts within individual rooms, parking lots and roads, as applicable.

B. In strict accordance with manufacturer's recommendations and as approved to ensure maximum permanence. Handle large fixtures with care to avoid deformation.

C. Support all fixtures from structural members. Provide additional intermediate members as required. Where fixtures are supported by a suspended ceiling system, securely fasten the fixtures to the ceiling system framing.

D. Wire fixtures received unwired from manufacturer.

E. Rewire fixture if required for any cause as required to complete the installation as indicated.

F. Cut stem hangers at job site if so required.

G. Install fixtures complete with fittings, diffusers, lamps, etc., wire and switch as indicated or specified.

H. Neatly align and properly secure abutting fixtures. Use reflector aligners where applicable for industrial units.
I. Provide adapters and mounting accessories for fixtures, matching the types indicated suitable for plaster or other types of ceilings. Coordinate with Architectural details and ceiling systems contractor prior to ordering the lighting fixtures.

J. Provide heat spacers for surface mounted units if required.

K. Ground all light fixtures as required by NEC, as a minimum.

3.2 EMERGENCY AND EXIT LIGHTING

A. Coordinate mounting arrangement and mounting height to avoid impaired visibility.

B. Wire and connect to panels with “lock on” circuit breakers.

3.3 OCCUPANCY SENSORS

A. Install in accordance with manufacturer's instructions.

B. Modify location and quantities as required by specific device used.

C. Time Delay: Set at maximum time off unless otherwise directed by Owner.

D. Sensitivity: Adjust for proper operation in each installation.

* * * * *
SECTION 16670
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Complete installation of lightning protection system.
   1. Air terminals and interconnecting conductors.
   2. Grounding and bonding for lightning protection.
B. Provide all materials, equipment, labor, and services for a complete system.

1.2 RELATED SECTIONS
A. SECTION 16170 – GROUNDING.

1.3 REFERENCES
B. ANSI/UL 96 - Lightning Protection Components.
C. UL 96A - Installation Requirements for Lightning Protection Systems.

1.4 SUBMITTALS
A. Shop Drawings: Layout of all air terminals, grounding electrodes, and bonding connections. Include all terminal, electrode, and conductor sizes, and connection and termination details.
B. Product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Thompson Lightning Protection Company.
B. Heary Bros. Lightning Protection.
C. Independent Protection Company, Inc.
D. Erico.

2.2 QUALITY ASSURANCE
A. Lightning protection shall conform to the requirements of Underwriters Laboratories Standards and the Lightning Protection Code NFPA Publication No. 780.

B. The system components furnished shall be products of a manufacturer regularly engaged in the production of lightning protection systems and shall be listed in the current edition of the Underwriters Laboratories Electrical Equipment list.

C. Underwriters Laboratories Master Label shall be furnished by the Contractor to certify that the lightning protection has been properly made and installed.

2.3 MATERIALS

A. Structural steel buildings can be considered electrically continuous, as described by paragraph 2141 and 2195 of Lightning Protection Code NFPA Publication No. 780.

B. The structural steel can be utilized as the main conductors of the lightning protection system.

C. The roof shall be protected by suitably grounded air terminals in accordance with NFPA No. 78 and as shown on the drawings. Air terminals shall be interconnected by a lightning conductor and bonded to the structural steel.

D. All Enclosed Columns shall be connected to the main ground loop embedded in the concrete floor slab and directly connected to ground rods.

E. Air terminals shall be solid copper, tapered to a point. Size of the air terminals shall be 5/8 inch diameter, 16 inches long unless otherwise shown on the drawings.

F. Above-grade connectors shall be bronze, bolted type, specifically designed for lightning protection systems. Connections below grade shall be the exothermic type.

G. Conductors shall be copper with minimum weight, strands, and purity, as required by the Lightning Protection Code. Sizes of the conductors shall be as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements.

C. Beginning of installation means installer accepts field conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and UL 96A.

B. The lightning protection system shall be installed as shown on the drawings.

C. The air terminals shall be firmly attached to the roof with the anchor bolts or with suitable adhesive.

D. Weighted bases will not be acceptable.
E. The lightning protection system shall be connected to the ground system as shown.

3.3 FIELD QUALITY CONTROL

A. Obtain services of Underwriters Laboratories, Inc. to provide inspection and certification of the lightning protection system under the provisions of UL 96A.

B. Obtain UL Master Label and attach to building at location directed by Owner's Representative.

* * * * *
SECTION 16671
TRANSIENT VOLTAGE SURGE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Transient voltage surge suppression panels.

1.2 REFERENCES
A. UL 1449, standard for transient voltage surge suppressor.
B. ANSI/IEEE C62.41.

1.3 SUBMITTALS
A. Dimensioned catalog cuts or drawings.
B. Copies of ringwave and impulse test results in accordance with ANSI/IEEE C62.41.
C. Complete product rating data.
D. Installation instructions.

1.4 WARRANTY
A. Minimum two years from delivery.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. MCG Surge Protection.

2.2 QUALITY ASSURANCE
A. Material and equipment must be standard cataloged products of manufacturer listed.

2.3 TRANSIENT VOLTAGE SURGE SUPPRESSOR
A. Solid state utilizing a multitude of voltage dependent metal oxide varistors.
B. MCOV (Maximum Continuous Operating Voltages): Not less than 125 percent to ensure the ability of the system to withstand temporary over-voltage conditions due to utility tolerances and facility distribution transformer strapping.
C. Single Pulse Surge Current Capacity as indicated.
D. Repetitive 10,000 Event Surge Current Capacity as indicated.

E. UL 1449 Suppression Modes
   1. Line to Neutral.
   2. Line to Ground.
   3. Line to Line.
   4. Neutral to Ground.

F. Models
   1. Building Entry: 402XT/202XT.
   2. Main/Branch Panel: 160M/120M.
   4. Local Panel: 80/40.

G. Terminations: Rated for low inductance cable.

H. Internal Connections: No plug-in component modules, quick disconnects, or printed circuit boards shall be in suppression current carrying paths.

I. NEMA 4 Enclosure.

J. Unit Status Indicator: Visual front panel indicating operation status of unit. Solid-state LED indicators.

PART 3 - EXECUTION

3.1 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. Mount adjacent to panels indicated on the single line diagram.

B. Connect in accordance with manufacturer's instructions to a circuit breaker, the ground bus and the neutral bus in the associated panel.

C. Utilize low inductance “Micro-Z” cable not exceeding manufacturer’s recommended length.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Power Conditioners – 15 KVA and larger.

1.2 REFERENCES

1.3 SUBMITTALS
   A. Product data.

1.4 OPERATION AND MAINTENANCE DATA
   A. Manuals for all equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER (NO SUBSTITUTION)
   A. Liebert “Datawave”.

2.2 QUALITY ASSURANCE
   A. Standard cataloged units of manufacturer listed.
   B. Final checkout and initial startup by Factory Technician.

2.3 POWER CONDITIONER
   A. Main input breaker.
   B. Main output breaker.
   C. Secondary class surge arrestor.
   D. Local monitoring “Volt-Current Monitor Panel”.
   E. Set for automatic restart after power loss.
   F. Include secondary panelboards if appropriate.
G. Include bypass switch if input and output voltages are identical.

H. Refer to drawings for individual power conditioner ratings.

PART 3 - EXECUTION

3.2 POWER CONDITIONER

A. Install at locations indicated.

B. Install under supervision of manufacturer’s representative.

C. Provide factory authorized personnel to instruct Owner’s Representative in operation and maintenance.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Complete installation and testing of fire detection and alarm system.
B. Coordination with Electric Boat Fire Department for remote reporting.
C. Provide all materials, equipment, labor, and services for a complete and operational system.

1.2 REFERENCES


1.3 SUBMITTALS

A. Product data and shop drawings showing system components and panel layouts.
B. Pre-installation wiring diagrams showing devices, equipment, and wiring.
C. Battery calculations.
D. As-built composite wiring information at the end of the project showing and identifying all the equipment, devices, conduits, conduit sizes, number of wires, wire numbers, terminal numbers, and junction boxes.
E. Certification that the system has been tested and operates as specified.

1.4 GUARANTEE

A. Guarantee all the equipment and wiring free from mechanical and electrical defects for a period of one (1) year from the date of completed installation acceptance. Replacements of parts or adjustments, including labor, made necessary by such defects, shall be rendered by the Contractor at no cost to Owner.
B. Provide two inspections of the equipment by an authorized representative of the equipment manufacturer during the fifth and eleventh months of the guarantee period.
C. All equipment replaced during the initial guarantee period shall be covered with an extended guarantee period of one year from the date of replacement.
D. Obtain receipts for the Owner for items "A" and "B" above and deliver copies to Engineer.

1.5 SYSTEM DESCRIPTION
A. Non-coded, fully point addressable, microprocessor based, supervised system.

B. Normal power input, 120 volt, single phase, A.C.

C. Standby Power Input: 24 volt D.C. from emergency power packs, sized to operate the detection circuits for 24 hours and operate alarm communication and auxiliary circuits for 10 minutes at the end of the period.

D. System Voltages

1. 24 volt D.C.
2. 120 volt A.C. for door hold-open devices.

E. Initiating device circuits shall be Class “B”, Style ”B” supervised design.

F. Notification appliance circuits shall be Class “B”, Style ”Y” supervised design.

G. Signaling line circuits shall be Class “B”, Style ”4” supervised design.

H. Both audible and visual indication of either alarm or trouble condition in any one or all zones, reduced standby battery pack voltage at the fire alarm panel and annunciator panels, operative power failure, an open circuit or short circuit or ground in the system. Include resound capability to ring bells on subsequent alarms.

I. Both alarm and trouble audible signals shall be silenced with a selector switch. Upon restoration of the system, the audible signal shall sound again until the switch is restored to its normal position.

J. Detectors above accessible ceiling, under raised floors or other spaces not in sight of a person at finished floor levels shall have remote indicator lights easily visible. Indicators for visible detectors shall be also provided, if so indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER (NO SUBSTITUTION)

A. Gamewell.

2.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years documented experience.

B. Installer: Company specializing in smoke detection and fire alarm systems with five years experience and licensed as fire alarm installing contractor.

2.3 FIRE ALARM CONTROL PANEL

A. Gamewell FCI E-3 Panel

B. Constructed of code gauge steel, NEMA 1 enclosure.

C. Baked-on enamel finish.
D. Dead front construction.

E. Door hinged and provided with flush cabinet door lock and key (duplicate).

F. Complete with all equipment and devices, housed internally, required to perform all the functions of the system.

G. All alarm and/or trouble indicating devices shall be provided and be visible with panel door closed.

H. Constant supervision and alarm for loss of 24 volt D.C. standby power.

I. Sized and equipped for the number of zones and spares indicated.

J. Power input (with an in-line removable fuse) through an integral filtering and surge suppression system capable of protecting the system from expected voltage surges and noise.

2.4 CODE TRANSMITTER

A. Local energy type, three-fold master.

2.5 FIRE ALARM GRAPHIC ANNUNCIATOR PANEL

A. Panel similar to fire alarm control panel except consisting of indicating lights and a graphic of the area outlines matching the floor plan by fire alarm zones, at approximate 1 inch equals 20 foot scale.

2.6 EMERGENCY POWER PACKS

A. Lead-acid (antimony or calcium), 24 volt D.C. batteries.

B. Automatic and solid-state high/low rate charging. No manual switching for either rate.

C. Voltmeter and ammeter.

D. Terminal for 120 volt A.C., single phase input and 24 volt D.C. output.

E. Provide protective devices to guard against overloads and short circuits.

F. Integral in fire alarm control panel.

2.7 MANUAL FIRE ALARM STATIONS

A. Pull-handle type dual action manual stations.

B. Key lock for test and reset.

C. Positive action sealed switch.

D. Complete with mounting accessories.

E. Painted red.

F. Contact assemblies as required.
G. Fully addressable by setting of switches within the station.

2.8 THERMAL DETECTORS
A. Fixed temperature type (200 degrees F or 135 degrees F as indicated).
B. Visible indication for operated detector.
C. Contact rating coordinated with system requirements.
D. Complete with mounting accessories.
E. Complete with addressable base.

2.9 SMOKE DETECTORS
A. To detect black or gray smoke: Analog photoelectric type with fixed temperature back up, ceiling detectors, duct detectors, and photobeam detectors.
B. To detect visible and invisible products of combustion: Analog ionization type, ceiling detectors.
C. Individually sensitivity adjustment - continuously variable.
D. Individual alarm lamp, remote lamps for hidden units, test key switches for duct detectors.
E. Trouble signal on failure of any one or more system components.
F. Operating voltage and number of contacts coordinated with system requirements.
G. Suitable for ceiling and/or duct mounting, complete with all accessories. Sampling tubes for duct detectors.
H. 360 degree smoke entry.
I. Back boxes suitable for the mounting arrangements involved.
J. Contain no radioactive material.
K. Continuously monitored for sensitivity degradation.
L. Fully addressable.

2.10 FIRE ALARM HORNS AND STROBES
A. Horns shall be surface wall mounting vibrating model, painted red.
B. Built-in or separately mounted. Xenon strobes with each horn, built-in reflectors, white lens with "FIRE" inscription in red letters. Maximum pulse duration 0.2 seconds, flash frequency 2 Hz (±1 HZ), minimum intensity 75 candela.

2.11 MAGNETIC DOOR HOLD OPEN DEVICES
A. 120 VAC holding coils.
B. Floor or wall mountings as required.
C. Mounting accessories as required.

D. Finish, brushed aluminum.

2.12 FAN AND EQUIPMENT SHUTDOWN RELAYS

A. 24V DC coils.

B. Each relay with minimum of 2 N.O. and 2 N.C. contacts, more as required. Contract ratings per circuit needs 10A minimum.

C. Common reset at F.A.C.P.

2.13 LOCATION LIGHTS

A. Red LED lamps in a light fixture as manufactured by Killark.

2.14 WIRING

A. Fire alarm power branch circuits - as specified in Section 16110.

B. Initiating and Signal Circuits: Power limited fire-protective signaling cable classified for fire and smoke characteristics, copper conductor, 300 volt insulation rated 105 degrees C, suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.

PART 3 - EXECUTION

3.1 FIRE ALARM CONTROL PANEL

A. Mounted at location indicated.

B. Mounting height 6 foot 6 inch maximum above finished floor to the top of the panel.

3.2 FIRE ALARM GRAPHIC ANNUNCIATOR PANEL

A. Mounted at location indicated.

3.3 EMERGENCY POWER PACKS

A. Internal to fire alarm control panel.

3.4 MANUAL FIRE ALARM STATIONS

A. Flush-mounted, at all the locations indicated in new construction and surface-mounted in suitable back boxes on existing walls.

B. Back boxes for surface-mounted units shall be full size and as furnished by the supplier.
3.5 THERMAL DETECTORS
   A. Ceiling mounted at locations indicated or specified.

3.6 SMOKE DETECTORS
   A. Ceiling or duct-mounted at locations indicated or specified. Suspended for photobeam type.
   B. Coordination information in mechanical drawings and specifications for duct detector locations.
   C. Remote pilots and test switches, including wiring, for the duct detectors.

3.7 FIRE ALARM HORNS AND STROBES
   A. Flush-mounted, at all the locations indicated in new construction and surface-mounted in suitable back boxes on existing walls.
   B. Back boxes for surface-mounted units shall be full size and as furnished by the supplier.

3.8 MAGNETIC DOOR HOLD OPEN DEVICES
   A. Mount and wire for the doors indicated.

3.9 FAN AND EQUIPMENT SHUTDOWN RELAYS
   A. One for each of the equipment requiring fire alarm shutdown.
   B. Wire into the holding coil circuit, ahead of other controls.
   C. Keep unsupervised wiring between relay and starter as short as possible.

3.10 SMOKE VENTS
   A. Wire to equipment furnished by General Contractor.

3.11 ELEVATOR CAPTURE, RECALL AND SHUTDOWN
   A. Coordinate with elevator installer.

3.12 SPRINKLER WATER FLOW AND VALVE TAMPER SWITCH CONNECTIONS
   A. Coordinate with fire protection installer.

3.13 PROGRAMMING
   A. The control panel shall be programmed by the approved supplier/installer.
3.14 LOCATION LIGHTS

A. Above each master box and pull station.

3.15 WIRING

A. Risers, wall and floor penetrations, and exposed wiring run in unfinished spaces shall be enclosed in suitable raceway as specified in Section 16110.

B. Wiring not mixed with or run in raceways for other systems.

C. Wiring run without raceway concealed above accessible ceilings shall be supported at required intervals with bridle rings from the building structure.

3.16 FIELD QUALITY CONTROL

A. An authorized representative of the manufacturer of the fire alarm equipment shall advise and assist the Contractor with installation, testing and instructing Owner's personnel on the operation and maintenance of the fire alarm system.

B. Test in accordance with NFPA 72.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Complete installation and testing of public address system.
B. All materials, equipment, labor, and services for a complete and operational system.

1.2 SUBMITTALS

A. Manufacturer's product data for all system components.
B. Complete system wiring diagrams showing all the field wiring and terminals.

1.3 SYSTEM DESCRIPTION

A. System to consist of a mixer/power amplifier with two inputs from the telephone system for paging and 8 separate and selectable zone outputs, plus all call, to speakers.

1.4 GUARANTEE

A. The Contractor shall guarantee all equipment and wiring free from defects for a period of one year from the date of acceptance of the system.
B. The manufacturer or supplier shall furnish without further cost to the Owner a one-year contract, effective from the date of acceptance of the system, for maintenance and inspection service of the manufacturer's equipment with a minimum of two inspections during the contract year, one at 5 months and one at 11 months.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dukane (Preferred)
B. Rauland.
C. Bogen.

2.2 QUALITY ASSURANCE

A. Certification from the supplier that the system has been tested and is operative as specified.
2.3 MIXER/POWER AMPLIFIER

A. Rated Output Power: As indicated.

B. Total Harmonic Distortion: Less than .5 percent, 20-20kHz.

C. Frequency Response: ±1 dB, 20-20kHz at full rated output.

D. Input Sensitivity: High impedance, 100 millivolts. Low impedance balanced, with optional transformer, 400 microvolts.

E. Hum and Noise: 90dB below rated output.

F. Output Loads: 8 ohms, 25 VCT (31.25 ohms), 70.7V (250 ohms).

G. Output Regulation: Better than 2 dB from no load to full load.

H. Input Impedances: High impedance, 50k ohms unbalanced. Low impedance, 600 ohms, balanced or unbalanced and 1:1 bridging with optional accessory plug-in transformers.

I. Power Requirements: 120 VAC, 60 Hz.

J. Enclosed, suitable for rack mounting.

K. With power cord.

L. Operating Temperature Range: -10 degrees C to +55 degrees C at rated output.

2.4 CEILING SPEAKERS

A. Loudspeakers

1. 8 inch diameter, 10 OZ. ceramic magnet, 8 ohm voice coil, 70-15000 Hz frequency response, 96 dB axial sensitivity at 4 feet with 1 watt input, 15 watts program material power handling capacity.

B. Transformer

1. 70V line voltage, 4 / 2 / 1 / 1/2 / 1/4 / 1/8 watt power taps, 8 ohms secondary impedance, screw terminal strips.

C. Enclosures

1. Round recessed steel housing, inner surfaces acoustically treated to prevent metallic resonance, 1/2 inch - 3/4 inch conduit knockouts, finished with rust retardant black primer coating, for 8 inch loudspeakers.

D. Baffles

1. White aluminum, 12 inch diameter, for 8 inch speakers, hidden loudspeaker mounting studs, hardware required.

E. Accessories

1. As needed.
2.5 HORN SPEAKERS

A. 30 watts, 8 ohms.
B. 70V line, 1.8, 3.7, 7.5, 15, 30 watt taps transformer, built-on.
C. Frequency Response: 225-14000 Hz.
D. Ferrite Magnet.
E. Sound level 125 dB @ 4 ft. on axis with 30 watts input @ 1000 Hz.
F. Weatherproof for exterior use.

2.6 WIRING

A. Speakers: No. 18 AWG, twisted pair, PVC jacket, 80 degrees C 300V rated for speakers.
B. Input: No. 18 AWG, shielded twisted pair, PVC jacket, 80 degrees C 300V rated.
A. Risers, wall and floor penetrations, and exposed wiring run in unfinished spaces shall be enclosed in suitable raceway as specified in Section 16110.
B. Wiring not mixed with or run in raceways for power wiring.
C. Wiring run without raceway concealed above accessible ceilings shall be supported at required intervals with bridle rings from the building structure or in cable tray.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Intercom devices.

1.2 SYSTEM DESCRIPTION
   A. Voice communication and signal between master and slave stations.

1.3 SUBMITTALS
   A. Catalog cuts showing standard construction and details.
   B. Wiring diagrams.

1.4 WARRANTY
   A. Complete warranty of system from all defects for one year from date of acceptance of a complete functional system.
   B. Provide 2 on-site inspections during the warranty period, one at 5 months, and one at 11 months, in addition to any warranty service calls. With Owner, document system performance and discrepancies.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Airphone.

2.2 QUALITY ASSURANCE
   A. Standard cataloged products of manufacturer listed.

2.3 INTERCOM MASTER
   A. Flush mounted master (Cat. No. LEF-1C).
   B. 12V DC power supply (Cat. No. PS-12C).

2.4 INTERCOM SLAVE
   A. Weather resistant.
2.5 WIRING
   A. As recommended by manufacturer.

PART 3 - EXECUTION

3.1 COORDINATION AND VERIFICATION
   A. Field verify conditions and locations.

3.2 EQUIPMENT
   A. Where indicated on drawings.
   B. In accordance with manufacturer’s instructions.

3.3 WIRING
   A. All wiring shall be run in metallic raceway.

3.4 FIELD QUALITY CONTROL
   A. Setup and test system in accordance with manufacturer’s instructions.
   B. Complete operational instructions to Owner designated personnel.

* * * * *
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Power wiring.
B. Disconnect switches where indicated.
C. Motor control equipment.

1.2 RELATED SECTIONS
A. SECTION 15170: ELECTRICAL COORDINATION (for coordination with Division 15).

1.3 SUBMITTALS
A. Catalog cuts showing standard construction and details.
B. Wiring diagrams for specific applications.

1.4 RESPONSIBILITY FOR FURNISHING EQUIPMENT.
A. Motorized equipment and motor controllers shall be furnished under the Division where the motorized equipment is specified, unless otherwise noted or unless the controller is to be part of one of the motor control centers.
B. The overload relay heater for each motor controller shall be furnished by others for the equipment furnished by others or under the Division furnishing the controller; however, the responsibility of correctly sizing the heaters is under Division 16.
C. The disconnecting means for each motor shall be furnished under Division 16 unless the Equipment Control Schedule notes otherwise, or unless the disconnecting means is built-in to the equipment or controller.

1.5 RESPONSIBILITY FOR INSTALLING EQUIPMENT
A. Motors and motorized equipment shall be installed under the Division or Section where they are specified, unless noted otherwise.
B. Motor controllers and disconnects shall be installed under Division 16, unless otherwise noted.
C. The Contractor responsible for Division 16 will provide power supply wiring from the panel through the disconnects (if required) to controllers and from the load contacts of the controllers to the motors or other loads. All other power wiring except factory pre-wired packaged equipment shall also be included.
D. Where the power supply circuit is also the control circuit that does not involve interposing relay or control power transformer, (such as would be the case in a unit heater with line voltage thermostat, a
water heater with a line voltage aquastat, a kitchen disposal with a line voltage solenoid valve, etc.), the wiring shall be included under Division 16. All other control and/or interlock wiring shall be provided under their respective divisions.

E. The electrical interlock wiring between controllers in motor control centers shall be done under Division 16. All other control wiring and interlocks for motors, motorized equipment or other systems being provided under other Divisions of this contract or provided by others shall not be under Division 16. The hook-ups of the wiring run under other divisions to Motor Control Centers shall be done under Division 16.

F. The responsibility of verifying the correct equipment locations prior to roughing in electrical conduits by checking drawings for other Divisions, or by others, is with Division 16.

1.6 SCHEDULES

A. The schedules are given for Contractor's convenience and do not relieve him of his responsibility of a complete and detailed take-off.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allen Bradley.

B. Square D.

2.2 QUALITY ASSURANCE

A. Material and equipment must be standard cataloged products of manufacturers listed.

2.3 MAGNETIC STARTERS

A. Magnetic starters shall conform to NEMA Standard ICS-1 and shall be sized as shown on the drawings. If not shown, the starters shall be sized in accordance with the requirements of NEMA Standard ICS-1. Except where otherwise shown or specified, the starters shall be for across-the-line starting. The starters shall be equipped with thermal overloads in each ungrounded conductor. Thermal overloads shall be sized in accordance with nameplate rating of motor supplied.

2.4 CONTROLLERS

A. Controllers shall be the magnetic, electrically held type, conforming to NEMA Standard ICS-1. The controllers shall be of the size shown on the drawings, and shall be suitable for the type of load they will control.
2.5 CIRCUIT BREAKERS

A. Circuit breakers shall be the molded case type. Trip setting and frame sizes shall be as shown on the drawings; when not shown, the trip setting shall be maximum setting permitted by the National Electrical Code, and frame size shall not be less than 100 amperes.

2.6 COMBINATION STARTERS AND CONTROLLERS

A. Combination starters and controllers shall be circuit breaker type, unless current limiting fuses are required to limit short circuit current to the contractor rating. The circuit breakers, starters, and controllers shall be as specified above. The circuit breaker or fusible switch shall be operable by an exterior handle clearly indicating ON/OFF positions. The handle shall be provided with means to lock the handle in the OFF Position by means of padlocks. All starters and controllers shall be provided with 120-volt-AC control transformers unless otherwise specified.

2.7 MISCELLANEOUS CONTROL DEVICES

A. Control devices shall be as shown on the drawings, as recommended by the equipment manufacturer and as required by the National Electrical Code. Pushbuttons and selector switches shall be of the heavy-duty, oil-tight type, rated 600 volts AC. Contacts shall be double break, silver-plated, and rated not less than 6 amperes continuous at 120 volts AC. The pilot lights shall be the 6S6 filament-bulb type. Red pilot lights shall be used to indicate ON or RUNNING conditions. Green pilot lights shall be used for OFF. Terminal blocks shall be rated 10 amperes minimum and shall be provided with marking strips. Relays shall be of type necessary to perform the required function and shall be rated in accordance with NEMA Standard ICS-1.

2.8 TIME DELAY RELAYS, AUTOMATIC RESET

A. Industrial grade - electric or electronic.
B. In NEMA 12 enclosures.
C. Double pole, double throw, 120V coils, 20A contacts.
D. Operation: Instantly off, delayed on (0-120 second time adjustable) during power interruptions and fire alarm fan/equipment shutdowns only.

2.9 MOTOR AND EQUIPMENT SCHEDULE

A. See drawings.
B. Equipment listed on schedule, but not appearing on drawings, will be field directed.
C. The horsepower ratings indicated on electrical drawings are for guidance only and do not limit or define the equipment size. When the electrically driven equipment furnished differs in power requirements from that indicated, the Contractor shall adjust the size of wiring, disconnecting devices, starters, and branch circuit protection in accordance with the requirements of the National Electrical Code at no additional cost to the Owner.
PART 3 - EXECUTION

3.1 STARTERS
   A. Wall mounted in NEMA 12 enclosures on backboards.
   B. Group mounted in Motor Control Centers.

3.2 TIME DELAY RELAYS & FAN SHUTDOWN RELAYS
   A. Wired into control circuit when indicated on Motor and Equipment Schedule.

3.3 DISCONNECTS
   A. Refer to Section 16400.

3.4 WIRING
   A. All wiring shall be in conduit.
   B. All wiring shall be number coded and identified at the ends of the wires and at the terminal blocks.

* * * * *