

MECHANICAL

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SECTION 15016

STARTING OF SYSTEMS

PART 1 - GENERAL

1.01 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Engineer and Owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of Contractor's personnel in accordance with manufacturer's instructions and recommendations.
- G. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report to the Engineer that equipment or system has been properly installed and is functioning correctly.

1.02 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operations and maintenance of products to Owner's personnel two weeks prior to date of final inspection.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 15022

ACCESS DOORS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 08305 - Access Doors

1.02 SUBMITTALS

- A. Shop and installation drawings shall indicate size, material, thickness and shape, method of fabrication, installation, and anchorage.

PART 2 - PRODUCT

2.01 GENERAL

- A. Access panels are to be provided at all fire dampers, hidden valves, plumbing chases, or elsewhere where access for servicing work installed by this contractor might occur and where shown on drawings.
- B. Access panels in ceilings and walls for concealed mechanical and plumbing equipment or items shall be provided by this contractor.
- C. Access doors for sheet metal ductwork for fire damper access, etc., shall be provided by this contractor.
- D. Product Manufacturer:
 - 1. Acceptable manufacturers of access panels and doors shall be Cesco, Milcor, Larsens, or an approved equal.

2.02 ACCESS PANELS

- A. Fire Rated Access Panels.
 - 1. Like Cesco FB Series, U.L. listed 1-1/2 hour "B" label. Frame shall be 16 gauge galvanized bonderized steel. Door shall be 20 gauge galvanized bonderized steel, welded pan type. The Flange of door shall be rolled, 1-1/4" wide. Hinge shall be galvanized steel with stainless steel pin, continuous piano type. The latch shall be a bolt type, operated by a flush key device - all keyed alike, optional knurled knob or prepared for mortise cylinder. Door closure shall be automatic, self latching, and contain interior latch release handle. Insulation shall be 2" thick and fire retardant. The finish shall be paint grip. Stainless steel door shall have #4 stain finish. Provide auxiliary ceiling spring for ceiling mounted units.
- B. Access Panels in existing walls or ceilings and remodel projects.
 - 1. Like Cesco W Series. Frame shall be 16 gauge galvanized bonderized steel. Door shall be 14 gauge galvanized bonderized steel, welded pan type. The Flange of door shall be rolled, 1-5/16" wide. Hinge shall be zinc plated, of the continuous, offset and concealed type. The latch shall be a flush mounted, tamper resistant cam or key operated cylinder lock. The finish shall be paint grip. Stainless steel door shall have #4 stain finish.

C. Access Panels in new drywall surfaces, walls or ceilings (after drywall is applied).

1. Like Cesco SR-II Slim Line Series. Frame shall be .060 6063-T5 extruded aluminum. Door shall be 14 gauge galvanized bonderized steel, welded pan type. The Flange of door shall be rolled, 1/2" wide. Hinge shall be zinc plated, of the continuous, offset and concealed type. The latch shall be a flush mounted, tamper resistant cam or key operated cylinder lock. The finish shall be paint grip.

D. Access Panels in new drywall surfaces, walls or ceilings (before drywall is applied).

1. Like Cesco SR-I Series. Frame shall be .060 6063-T5 extruded aluminum. Door shall be 14 gauge galvanized bonderized steel, welded pan type. The finish beading of door shall be 5/8" offset extruded aluminum, 1-5/16" wide. Hinge shall be zinc plated, of the continuous, offset and concealed type. The latch shall be a flush mounted, tamper resistant cam or key operated cylinder lock. The finish shall be paint grip.

E. Access Panels in new plaster surfaces, walls or ceilings.

1. Like Cesco PX-RX Series. Frame shall be 16 gauge galvanized bonderized steel. Door shall be 18 gauge galvanized bonderized steel, recessed 1" and lined with self furring galvanized steel lath. The finish beading of door shall be expansion casing with 3" wide galvanized steel plaster lath. Hinge shall be zinc plated, of the continuous, offset and concealed type. The latch shall be a flush mounted, tamper resistant cam or key operated cylinder lock. Sleeves shall be welded to the door around cams or key lock to protect plaster. The finish shall be paint grip.

2.03 ACCESS DOORS

A. Access Doors in Ductwork.

1. Doors are to have knob tightening mechanism to secure doors in place, suitable for intended pressure application
2. Doors are to be U.L. labeled, with fire rating consistent with wall or ceiling in which access door is to be installed.
3. Like Cesco HAD Series. Frame to be 22 gauge galvanized steel. The door panels shall be 24 gauge galvanized steel. The insulation shall be 1" thick fiberglass. Gasket shall be P.V.C. foam tape. The hinge shall be zinc plated steel continuous type and the latches shall be galvanized steel sash type with galvanized steel strikes.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide access panels for all devices or equipment concealed or enclosed behind walls, ceiling, bulkheads, floors, and similar spaces which may require future servicing. These access doors are to be provided by this contractor.
- B. Unless noted otherwise on the Drawings/Details, access panels and doors are to be maximum 16" wide by 16" long, or (for duct applications) 16" long and 2" less than duct width, according to application location.

END OF SECTION

SECTION 15024

TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 REFERENCES

A. The latest issues of the following documents form a part of this specification to the extent indicated hereinafter.

1. American Society of Testing Materials (ASTM).
 - a. D698 Standard Proctor Maximum Dry Density.
 - b. D1556-64 Density of Soil in Place by the Sand Cone Method.
 - c. D2167-66 Density of Soil in Place by the Rubber Balloon Method.

B. SECTION 02485 - BACKFILLING

C. SECTION 15060 - PIPE AND PIPE FITTINGS

PART 2 - PRODUCTS

2.01 MATERIALS

A. Select aggregate.

1. No. 14-2 sand in accordance with ISHSS 903.01(g).

PART 3 - EXECUTION

3.01 TRENCHING

A. General.

1. All excavation of every description and whatever substances encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins.
2. All excavated materials not required or suitable for backfill shall be removed or wasted. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if the pipe can be safely and properly installed and backfill can be properly compacted in such tunnel sections, or where specified on the document drawings.

B. Trench Excavation

1. Trenches shall be of the necessary width for proper laying of pipe or conduit. The banks of trenches shall be as nearly vertical as practicable. Care shall be taken not to over-excavate. The bottom of the trenches shall be accurately graded to provide a uniform surface for the type of bedding specified. Stones shall be removed as necessary to avoid point bearing.

3.02 BACKFILLING

A. General

1. Except as otherwise specified for special conditions of over-depths, trenches shall be backfilled to the ground surface with selected material as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be restored to its original condition as near as practicable and as hereinafter specified.

B. Backfilling trench

1. Except for special requirements for pavements, the trench shall be backfilled with sand around the pipe. The balance of the trench shall be backfilled using excavated material that is free of stones larger than 3 inches from the compacted sand up to approximately 4" below finished grade. Trenches will be compacted to 88% of maximum density for sodded or seeded areas and 95% for roadways, parking areas, and walks.
 - a. For roadways, parking areas, and walks, the balance of the trench shall be backfilled using aggregate material #53 stone or sand and compacted to 95%.
2. In sodded or seeded areas, trench will have a minimum of 4 inch topsoil provided. (Seed and straw by Owner.)

C. Trenches within the building.

1. Entire trench shall be backfilled with No. 14-2 sand in 6-inch layers to sub-grade line for capillary water barrier.
2. Floor patching will be done as part of this contract.

END OF SECTION

SECTION 15042

SYSTEMS TESTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED WORK

- A. Other testing, such as will be required for domestic water and waste piping systems, and for adjustments in control or wiring devices, shall be specified in their appropriate system sections.
- B. Section 15810 - Furnaces.
- G. Section 15820 - Exhaust Fans.
- H. Section 15840 - Ductwork.

1.02 TRADE RESPONSIBILITIES

- A. The work described in this section of the Specifications is to be the responsibility of an independent or certified balancing trade. Provide information on prospective contractors to engineer for approval at least 10 days before bid date.
- B. Coordination and communications shall be maintained with the following:
 - 1. The Owner's representative.
 - a. To clear any questions covering the performance expected.
 - b. To notify the Architect and Owner's representative 48 hours prior to all tests and final adjustments.
 - c. To submit to the Owner, through the Architect, a written report in triplicate for each system consisting of procedure and result.
 - 2. Equipment Suppliers.
 - a. To obtain any data required for adjustment, balancing or operating instructions.
- C. Scheduling of work shall be arranged so that as much of the balancing work as possible be done while the Contractor's men are still on the job.

1. The Owner's moving operation and regular use of the building shall not be interrupted.

1.03 JOB CONDITIONS

- A. Systems equipment shall be completely installed and in continuous operation as required to accomplish the test, adjust and balance work specified.
- B. Test, adjust and balance shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions, or shall be mathematically corrected to specified design conditions.
- C. Testing and balancing work shall be initiated only after the applicable systems start-up procedures have been completed by the mechanical trades.

1.04 ENGINEER QUALIFICATIONS

- A. Submit biographical data on employee proposed to directly supervise the test, adjust and balance work. Data shall indicate at least five years' experience in the mechanical contracting industry, engaged in heating, ventilating, and air conditioning work, or a certificate showing equivalent educational background for testing and balancing work.

1.05 SUBMITTALS

A. Data Sheets.

1. Submit data sheets on each item of testing equipment required.
2. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.

B. Report Forms.

1. Submit specimen copies of report forms.
2. Forms shall be 8-1/2 by 11 inch paper for looseleaf binding, with blanks for listing the required test ratings and for certification of report.
3. Reports shall be on standard AABC or NEBB test forms or similar forms as approved by the Architect.

- C. Submit three certified copies of test reports to the Architect for review and distribution to the Owner.

PART 2 - INSTRUMENTS

2.01 TEST INSTRUMENTS

- A. Test instruments required for the testing, balancing and adjusting operation shall be furnished by, and remain in the possession of, the balancing trade.
- B. All instruments must be properly checked and calibrated to obtain accurate readings and shall be available to the Architect's representative to facilitate spot checks of the balancing work.

2.02 AIR BALANCE INSTRUMENTS

- A. Alnor Velometer with Probes and Alnor Pitot Tube, or approved equal.
- B. Rotating Vane Anemometer Taylor Instrument Company, 4 inch size, or approved equal.
- C. ASHRAE Standard Pitot Tubes, stainless steel 5/16 inch outside diameter, lengths 18 inches and 36 inches: Dwyer Model 160, or equal.
- D. Magnehelic Differential Air Pressure Gauges, 0 to 0.5 inches, 0 to 1.0 inch and 0 to 5.0 inches water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube: Dwyer Series 2000, or equal.
- E. Combination Inclined-Vertical Portable Manometer, range 0 to 5.0 inches H₂O: Dwyer Number 400, or equal.
- F. Portable Type Hook Gauge, range 0 to 12 inches H₂O: Dwyer Number 1425, or equal.
- G. Portable Flexible U-Tube Manometer, magnetic mounting clips, range 18 inches H₂O: Dwyer Number 1215-20, or equal.

2.03 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

- A. Insertion thermometers, with graduations at 0.5°F for air and 0.1°F for water.
- B. Sling Psychrometer.
- C. Tachometer, centrifugal type: Stewart-Warner, or equal.

- D. Revolution Counter.
- E. Clamp-on Volt-Ammeter, minimum ranges: 0/600 volts on three scales; 0/800 on five scales.
- F. Recorders 7-Day Chart, portable type for temperature and humidity.
- G. Portable Orsat Flue-Gas Analyzer for measuring CO₂, O and CO.

2.04 INSTRUMENT TEST HOLES

- A. Test holes shall be made of cast aluminum, with gasketed screw cap and base.
- B. Test holes shall be as manufactured by Ventfabrics #699, or approved equal.

2.05 SHEAVES

- A. ***Balancing contractor shall be responsible for all sheave adjustments, to include replacement if necessary, in order to provide proper fan air balance.***

PART 3 - EXECUTION

3.01 TEST HOLE LOCATIONS

- A. Test holes shall be installed at the inlet and outlet of all air handling unit fans, exhaust fans, utility fans, etc., and elsewhere as required by the balancing trade to facilitate traverses and to test the air systems.

3.02 AIR SYSTEMS

- A. Test, adjust and balance systems in accordance with the following requirements.
- B. Preliminary.
 - 1. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.
 - 2. Use manufacturer's ratings for all equipment to make required calculations except where field test shows ratings to be impractical.
- C. Central System.

1. Test and adjust supply, return, exhaust and relief fan RRMS to design requirements within the limits of mechanical equipment provided..
 2. Test record motor voltage and running amperes including motor nameplate data, and starter heater ratings.
 3. Make Pitot tube traverse of main supply, exhaust and return ducts, determine CFM at fans, and adjust fans to design.
 4. Test and record system static pressure, suction and discharge.
 5. Test and adjust system for design outside air, CFM
 6. Test and adjust system for design recirculated air, CFM.
 7. Test and record heating apparatus entering air temperatures, dry bulb.
 8. Test and record cooling apparatus entering air temperatures, dry bulb and wet bulb.
 9. Test and record heating apparatus leaving air temperatures, dry bulb and wet bulb.
 10. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.
- D. Distribution: Adjust zones or branch ducts to proper design CFM, supply and return.
- E. Air Terminals.
1. Identify each air terminal from reports as to location and determine required flow reading.
 2. Test and adjust each air terminal to within 10% of design requirements.
 3. Test procedure on air terminals shall include comparison of required FPM velocity and observed velocity, adjustment of terminal, and comparison of required CFM and observed CFM after adjustment.
 4. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.
- F. Verification:

1. Prepare summation of readings of observed CFM for each system, compare with required CFM, and verify that duct losses are within specified allowable range.
2. Verify design CFM at fans as described in 3.02, C.3 above.

3.03 REFRIGERATION CAPACITY TESTS

- A. Conduct refrigeration capacity test during a period of stable operation.
- B. Verify settings of safety and operating controls.
- C. Make three trial observations, record readings of:
 1. Refrigerant temperatures accurate to 1°F.
 2. Compressor power input readings of volts and amperes in each phase, accurate to nearest 100 VA.
- D. Performance Report.
 1. Use readings to calculate tons of refrigeration capacity along with power input required for that capacity and compare with manufacturer's ratings to determine percent effectiveness.

3.04 FLUE-GAS TESTS

- A. Perform and record Orsat flue-gas analysis at the boiler and water heater.

3.05 AUTOMATIC CONTROL SYSTEM

- A. In cooperation with the control installer's representative, set and adjust automatically operated devices to achieve required sequence of operations.
- B. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by control system installer.

3.08 EXCLUSIONS

- A. No water filled system tests shall be conducted for an overnight time period or at any time when the systems will be left filled and unattended.

END OF SECTION

SECTION 15047

IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 09900 - Painting (includes color coding).
- B. Section 15025 - Mechanical Systems Painting.

1.02 SUBMITTALS

- A. Submit paint color chips, labels, plates, and samples of tags.

1.03 REFERENCES

- A. Current editions of publications of the following Institutes, Associations, Societies and Agencies are referred to in this Section.
 - 1. American National Standards Institute, ANSI.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Valve and Equipment Name Plates: Engraved white plastic with black 1" lettering and numbers.

2.02 LABELS

- A. Labeling may be done by using pipe marking system with flow arrows as manufactured by Brady, Seton or approved equal.

PART 3 - EXECUTION

3.01 VALVE TAGS

- A. Provide tags for all valves. Provide second tag for gas and domestic hot water valves behind access panels or concealed in walls or above ceilings.
 - 1. Tags shall be stamped with functional use (gas shutoff; domestic hot water recirculation line balance valve, etc.) and shall show normal position of valve (N.O. or N.C.), and the piping system function (P.,H.,C.).
 - 2. Chain tags to valves and apply tags to access panels or ceiling grid with adhesive.

3.02 EQUIPMENT NAME PLATES

- A. Plates shall be mounted on or adjacent to the equipment. All equipment in finished rooms will have

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location of the name plates approved by the Architect.

3.03 BANDING AND LABELING

- A. Banding consists of providing a painted band around the pipe of sufficient width to receive specified labels.
 - a. Bands, in general, shall be applied 30 feet on center along the pipe, at each side of walls or floors and at branches from the main.
- B. Labeling consists of providing 3/4 inch high stenciled black letters and flow arrows. Labels shall indicate pipe name and direction of flow.
 - a. Apply labels at all color bands.
 - b. Apply labels for gas and domestic water piping on center along the pipe or duct, at each side of walls or floors and at branches and mains.
- C. Provide label on all fans, air handling units, gas shutoff valves, emergency shutoff valves, etc.

END OF SECTION

SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15010 - General Provisions
 - 1. Seismic Restraints
- B. Section 15094 - Hangers and Supports.
- C. Section 15100 - Valves.
- D. Section 15250 - Piping and Equipment Insulation
- E. Section 15164 - Flexible Connectors.
- F. Section 15250 - Pipe and Equipment Insulation
- G. Section 15401 - Domestic Water Supply and Treatment

1.02 PRODUCT HANDLING

- A. Store pipe at the site in an orderly manner, protected from dirt, weather and mechanical damage.

1.03 REFERENCES

- A. Current editions of publications of the following institutes, associations, societies and agencies are referred to in this Section.
 - 1. American Society of Testing Materials.

PART 2 - PRODUCTS

2.01 PIPE

- A. Black Steel, ASTM A-120.
- B. Cast Iron, ASTM A-74.
- C. Type "L" Hard Copper, ASTM B-88.
- D. Type "K" Soft Copper, ASTM B-88.
- E. Polyvinyl Chloride (PVC) Pipe, ASTM D-2665-68.
- F. DWV Grade Aluminum Pipe
- G. Plastic Coated Black Steel Pipe
- H. Polybutylene (AGA Approved)
- I. Polypropylene Pipe, ASTM D-2146, UL-94-SE-0.

2.02 PIPE FITTINGS

- A. Black Steel, ASTM A-120.

1. Two inches and smaller shall be threaded, ASA 125 pound and 250 pound, cast iron fittings, threaded valves and specialties.
 2. Two and one-half inches and larger shall be welded, Schedule 80 and 40, welded fittings, flanged valves and specialties.
 3. Two inches and smaller for gas piping systems, threaded malleable fittings, threaded valves and specialties.
- B. Malleable Iron Fittings, ASTM B16.3-1951.
1. ASA 150 pound threaded fittings, threaded valves and specialties.
- C. Copper Pipe, ASTM B-88.
1. Type "L" hard copper shall be soldered, soldered end fittings, soldered or screwed valves and specialties.
 2. Type "K" soft copper shall be soldered extruded copper fittings, valves and specialties.
- D. Cast Iron, ASTM A-74.
1. Three inches and larger shall be service weight type, bell and spigot compression or caulked joints, or no-hub couplings.
 2. Two and one-half inches and smaller shall be bell and spigot I.P.S. cast iron, caulked joints or no-hub couplings.
- E. Plastic Piping, ASTM D-2751. (ASTM D-2146 for Polypropylene)
1. Shall be Schedule (40) or (80) plastic and shall have solvent weld type fittings, threaded solvent weld adapted for threaded valves and specialties.

2.03 MATERIAL SCHEDULE

- A. Domestic water lines shall be type "L" hard copper pipe above grade or inside the building and type "K" soft copper pipe below grade.
- B. Refrigerant Condensate drain lines shall be type "L" hard copper.
- C. Sanitary Soil, Waste and Vent Lines.
1. All buried or inaccessible soil, waste and vent piping inside and within five (5) feet of the building shall be service weight cast iron, bell and spigot or no-hub; or DWV grade aluminum pipe; or DWV Plastic Pipe.
 2. All vent piping shall be service weight cast iron, DWV aluminum pipe, or PVC.
- D. Roof conductors shall be service weight bell and spigot cast iron, no-hub cast iron, PVC or IPS cast iron pipe above grade and service weight bell and spigot, PVC or no-hub cast iron pipe below grade.

1. Use of no-hub cast iron pipe on vertical stacks shall be limited to 20' in height, unless a horizontal offset is provided at such intervals and securely anchored to the structure in at least two locations.

E. Gas Piping (Low Pressure - Under 1 psig)

1. Above ground gas lines shall be Schedule 40 black steel pipe with malleable iron threaded fittings or Schedule 40 welded fittings.
2. Outside building, piping shall be plastic coated schedule 40 black steel or AGA approved plastic pipe. Buried lines shall be polyethylene coated Schedule 40 black steel with polyethylene heat shrunk pipe joint sleeves and welded fittings. Pipe and sleeves manufactured by Plexco or approved equal.

F. Gas Piping (Medium Pressure - 1 psig to 10 psig)

1. Above ground gas lines shall be Schedule 40 black steel pipe.
 - a. All piping 2-1/2" and smaller shall have malleable iron threaded screwed fittings or Schedule 40 welded fittings.
 - b. All piping 3" and larger shall have Schedule 40 welded fittings.
 - c. Outside building, piping shall be plastic coated schedule 40 black steel . Buried lines shall be polyethylene coated Schedule 40 black steel with polyethylene heat shrunk pipe joint sleeves and welded fittings. Pipe and sleeves manufactured by Plexco or approved equal.

G. Refrigerant lines shall be type "L" hard copper pipe.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All piping shall have all scale and dirt removed both outside and inside before installation.
- B. The ends of all pipe shall be reamed to remove the burrs.
- C. All piping shall be anchored and guided, wherever it may be deemed necessary, in order to maintain proper control of pipe movement. Anchors and guides shall meet the approval of the Engineer.
- D. Provision shall be made to absorb all pipe expansion and contraction without injury to the pipe or the equipment it services.
- E. All piping shall be held level except where pitch is specified or shown on the drawings. All low points shall have drain valves.
- F. The drawings are intended to show the proper size and location of all piping, but it may be necessary in some cases to change the location of some piping in order to pass immovable obstructions, which shall be done without extra charge by this trade. Under no circumstances will the indicated pipe size be changed without written instructions from the Engineer.

- G. Provide all valves and fittings shown on the drawings called for in the specifications or otherwise required.
- H. No piping shall be run exposed except in equipment, utility, mechanical or similar rooms, or where so noted on the drawings. Wherever possible, piping shall be run above ceiling, in pipe spaces, etc. This trade must have the piping in place and tested before spaces are closed off by other trades. Pipe connections to terminal devices shall be run concealed.
- I. All piping shall be run square and plumb, close to ceilings and walls or as noted on drawings.
- J. Branch connections of 90 degree will be made with welding tees or Weldolets, Sockolets and Thredolets. Branch connections of 45 degree, or off of elbows, will be made with Latrolets and Elbolets respectively, with butt, socket or threaded outlets. Branch connections 2" and lower, which include a control device within 6" of the main, may be made with Nipolets. Weldolets, Sockolets, Thredolets, Latrolets, Elbolets, and Nipolets shall be a manufactured by Bonney Forge Division, or similar product by Allied Piping Products Co.
- K. All hot return mains shall have branches taken from the bottom of the mains. Swing joints shall be provided where shown and elsewhere expansion of mains would require them.
- L. Every attempt has been made while preparing the drawings, to keep unrelated pipe from passing through hazardous areas or rooms such as elevator equipment rooms, elevator shafts, electrical switchgear rooms, etc. However, this Contractor shall reroute pipe to avoid this type of installation if at all possible (even if it is shown on the drawings) only after advising the Engineer's representative of his proposed rerouting.

3.02 PIPE UNIONS

- A. Where pipes of different metals connect, ferrous to non-ferrous, a dielectric or cast brass union shall be installed.

3.03 WELDED CONNECTIONS

- A. All joints in piping systems specified or noted to be welded shall be fusion welded, using standard catalog product welding fittings. All welders must be certified.
- B. All pipe ends shall be beveled at 45 degrees to within 1/16" of inside wall. Abutting edges shall be sufficiently separated to provide for expansion. All welds shall be continuous around pipe and shall be made of sound metal, thoroughly fused into the ends of the pipe to the bottom of the "V", and built up in excess of the pipe wall. Fillet welds shall be built up to a depth of 1-1/4 times the wall thickness. Branch connections shall be made up with welded fittings.

3.04 SOLDERED CONNECTIONS

- A. All soldered pipe shall be joined using standard catalog products.
- B. All solder shall be lead free solder for plumbing and heating water lines. All joints shall be carefully made up and tested. Copperized flux soldering methods and joints shall be accepted on water lines 250 degrees or less.

- C. Pipe or tube shall be cut square and true, and special care shall be taken to insure that it is not forced out of round. Surfaces to receive solder shall be cleaned bright with emery cloth.
- D. Soldering shall be done with no more heat than that required to assure a sound joint. Burned valve bodies, fittings, pipe, etc., will be cause for rejection.

3.05 CAULKED CONNECTIONS

- A. All joints for cast iron pipe shall be made up with packed Oakum and pure pig lead, well caulked into the hub. 1-1/2 pounds of lead will be used for each joint for each inch in diameter. Double "O-Ring" type Neoprene compression gasket joints may be used. Such gaskets will be "Ty-Seal" by Tyler Pipe and Foundry Co. or approved equal.

3.06 THREADED CONNECTIONS

- A. All threads shall be cut full and true, and piping shall make up to line.
- B. Threaded connections shall be made up so that no more than two full threads are exposed and the completed joint.
- C. When iron-pipe-size cast iron or galvanized steel pipe is used for waste or drain lines, fittings shall be Durham recessed black cast iron drainage fittings, and when used for vent lines, fittings shall be standard black cast iron fittings.

3.07 ELBOWS

- A. All elbows in climate control water lines shall be long radius type.

3.08 SOIL, WASTE, AND VENT PIPING INSTALLATION

- A. Cast Iron Drain Installation.
 - 1. All inside drainage pipes shall be laid with a pitch of 1/4" per foot unless otherwise shown or specified. All joints for bell and spigot cast iron drainage pipe, buried or inaccessible, shall be made watertight with packed oakum and pure pig lead, well caulked into the hub. One and one-half pounds of lead shall be used at each joint for each inch in diameter. Double O-ring type of Neoprene Compression gaskets, such as "Ty-Seal" by Tyler Pipe and Foundry Co. may be used. No-hub systems shall use gasketed stainless steel banding mechanical fasteners. All cast iron pipe buried in the ground shall have a firm bearing along the entire length of undisturbed earth.
 - 2. The bell of all horizontal pipe shall not rest upon the earth, but have free area for caulking.
 - 3. Any junction shall be made with a "Y" branch. Cleanouts are to be provided where shown or where necessary.
 - 4. All openings for connections must be closed with screw plugs until used, and all hand holes must be closed at once and the sewer kept clean. Any earth or foreign matter that may get into the sewer must be removed by this trade. Any existing piping made obsolete by the work of this project shall be removed and openings plugged.

- B. Vent Pipes and Flashing.

- 1. Provide all required vents from soil and waste pipes. All vents are to extend 12" above the roof line

and be provided with regular roof connections to receive flashing made for this purpose.

2. Where vents are carried through the finished roof, these shall be installed before the roof is installed, or that portion of the roof shall be cut and same repaired by qualified and experienced men in the particular trades to which the respective kinds of work belong.

3.09 SEWERS

- A. When minimum clearances of 18" vertical and 10'-0" horizontal cannot be maintained between buried water piping and sewers, the sewers shall be constructed of "water-works" grade cast iron pipe with mechanical joints.
 1. Sewer shall be cast iron when running parallel to water pipe and the above minimum requirements cannot be met.
 2. Sewer shall be cast iron when crossing water pipe and the above minimum requirements cannot be met. Cast iron shall extend from point of crossing to 10'-0" on each side and shall be located so the joints are as far away from the water pipe as possible.
- B. Sanitary Sewer.
 1. Provide the connections of the sewers to the building drains. The connection shall be made by extending the building drain into the main or branch sewer a distance of not less than one foot, packing with oakum to a depth of 6" and then properly cementing.
 2. A cleanout connection shall be provided on each building drain, outside the foundation walls and as near to the wall as is practicable. Cleanouts also shall be located at each change in direction and branch connection. Cleanouts shall have plugged extensions brought to finished grade.
- C. Storm Sewers.
 1. Unless otherwise noted or directed by the Architect, no sewer shall be laid at depth of less than 3'-0" below grade. Sewers shall be laid to the grades shown on the drawings. Where grades are not given, the sewer shall be laid at a grade of not less than 1/8" per foot of length.
 2. Provide sewers only out to a point 5'-0" from the building outside wall, unless directed otherwise on the drawings.

3.10 OUTDOOR SOIL AND WASTE PIPING FREEZE PROTECTION

- A. Provide a protective system consisting of 1" pre-moulded fiberglass insulation having a "k" factor of .23 maximum at 75 degrees F. mean and electrical tracer tape. Wrap the pipe with the electric tape and then with the fiberglass insulation. Tracer tape shall be installed before insulation work begins. Insulation shall have a weatherproof jacket consisting of .016" aluminum sheeting pre-moulded and joined with a snap on strap of plastic sealing compound banded in place. Insulation shall be Johns-Manville "Metal-Lok" or approved equal.

3.11 SUSPENDED DRAINS

- A. Any suspended drain line serving fixtures on floors above shall be suspended from the floor as high as possible with a grade of not less than 1/8" per foot in length unless otherwise directed by the Architect.

- B. These pipes shall be firmly secured with iron hangers not more than 6' apart, and each fitting for risers shall be properly supported by iron hangers.
- C. All junctions shall be made with "Y" branches and all deflections in line or grade made with proper curved fitting. All joints, if screwed, shall be made with full threads, coated with approved pipe joint compound.
- D. All suspended soil, waste, or roof conductor piping shall be provided with a sheetmetal drip pan below when located above kitchen areas, food storage areas, sterile supply areas, operating rooms, etc.
 - 1. Pan shall be 2" wider than the nominal pipe size of pipe located above. Pan shall be 2" deep.
 - 2. Pan shall be 3" below bottom of pipe, maintain a constant slope of 1/8" per foot and terminate with low point drains as required.
 - 3. Low point drains shall be same size as the largest pipe served by a given section of of drip pan. Drains must terminate at a floor drain or an open site drain with an approved air gap at an approved location.

3.11 ROUGH-IN PIPING

- A. Provide rough-in and final connection for all fixtures indicated on drawings.
- B. Rough-in piping shall be stubbed three inches from the finished building surfaces. Temporarily plug and cap piping until equipment is ready for final installation.
- C. Obtain dimensioned shop drawings from the equipment suppliers before roughing-in for any equipment.

3.12 TESTING DRAINAGE SYSTEMS

- A. The drainage systems shall be tested by plugging the drainage outlets and filling the systems with water which is then permitted to stand thus for eight (8) hours. A hydrostatic head of 10 feet of water must be attained for the entire test period.
- B. Tests shall be performed before any covering or backfilling is done and before piping is built in or concealed.
- C. The system shall be considered satisfactory only if there is no loss of water or leakage for the duration of the test period.

END OF SECTION

SECTION 15080
PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15060 - Pipe and Pipe Fittings.
- B. Section 15170 - Meters and Gauges.
- C. Section 15711 - Water Specialties.

1.02 SUBMITTALS

- A. Shop drawings shall be required for approval by the engineer on each type of air vent, strainer, water hammer eliminator, mixing valve, flow meter, vacuum breaker, expansion joint, etc. to be installed on the Project.

PART 2 - PRODUCTS

2.01 AIR VENTS

- A. Air Vents shall be by B&G, Hoffman, Thrush, Sarco, Metraflex or Mueller.
 - 1. Manual air vents shall be like B&G 4V or approved equal.
 - 2. Automatic air vents shall be Metraflex #MV-15, Armstrong Mach. Works Model 706 or Muessco Model 8-AV.

2.02 STRAINERS

- A. Strainers shall have iron bodies in steel lines and cast bronze or brass bodies in copper lines, Y pattern, 3/64" perforated brass screens on closed water systems, and 1/8" perforated brass screens on open water systems. Strainers 2" and larger shall have blow down connection with nipple and bronze body type ball valve. 2-1/2" and larger shall be flanged type, 2" and smaller shall be screwed type. Strainers shall be Muessco Model 351, 352, 851 or 852 in copper lines. Strainers shall be Muessco Model 11, 751 or 752 in steel lines. Duplex operation shall make it possible to clean and/or service the strainer while pumping system is in operation. Strainer of equal quality by Armstrong, Hoffman, Dunham-Bush may be used.

2.03 EXPANSION TANK

- A. Tank shall be bladder style tank, with air pressure charged to provide adequate system pressure.
- B. Tank shall be as manufactured by Woods, Taco, Bell & Gosset or approved equal.

2.04 WATER HAMMER ARRESTER

- A. Device shall conform to ANSI A112-26-1 and have a lifetime warranty.

- B. Device shall be a copper tube chamber with a permanently sealed 60 psig air charge above a triple O-ring piston.
- C. Device shall be the Hydra-Rester as manufactured by Sioux Chief MFG or an approved equal.

PART 3 - EXECUTION

3.01 AIR VENTS

- A. Manual air vents shall be installed in all accessible high points of the system.
- B. Automatic air vents shall be installed in all high points of the system which are not accessible or air control devices as required. An overflow line shall be run from the valve to the nearest floor drain service sink or open site drain. Provide ball type shut valve on the inlet side of all automatic air vents.

3.02 STRAINERS

- A. Provide strainers where shown on the Drawings and up stream from any automatic valve, trap, hydronic heat pump, and coil. On strainers 2" and larger, provide nipple and shut-off valve for blowdown.
- B. Strainers 2" and larger shall be pulled and cleaned once, immediately prior to the time of Owner's acceptance, and once again approximately one month prior to termination of the guarantee period.

3.03 EXPANSION LOOPS AND JOINTS

- A. Install where required and shown to absorb pipe expansion and contractions. Care shall be used to effectively guide the pipe in all directions at the beginning and end of each loop or joint, and to locate anchors where shown and required.

3.04 WATER HAMMER ARRESTER

- A. The quantity, sizing, and placement of this device shall be determined by the Manufacture.
- B. Device shall be installed at the end of all domestic water lines with flush valves or other quick-closing valves.

END OF SECTION

SECTION 15094

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15010 - General Provisions
 - 1. Seismic Restraints
- B. Section 15060 - Pipe and Pipe Fittings.
- C. Section 15250 - Piping and Equipment.

1.02 SUBMITTALS

- A. Submit shop and installation drawings of each type of support to Engineer for approval.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Michigan Hanger Co.
- B. F&S Industries.
- C. Fee & Mason.
- D. Grinnell Company.
- E. Elcen Company.
- F. B-Line.
- G. Unistrut

2.02 PIPE HANGERS AND SUPPORTS

- A. Insulated Pipes.
 - 1. For insulated pipes, provide F & S Fig. 980 plates curved to fit exterior of insulation, with lateral surface covering the lower 1/2 of the insulation circumference. Provide support under lower part of insulation to prevent crushing of insulation at hanger or support, or a complete bonded adjustable hanger assembly with rigid insulation and saddle plate like Michigan Hanger Company #1031 or #4031.
- B. Uninsulated Pipes.
 - 1. F&S figure #87 or approved equal, adjustable band hangers, for all hangers up to and including 2" diameter pipes.
 - 2. F&S figure #86, or approved equal, wrought clevis hangers for all pipes larger than 2" diameter, with solid or threaded steel rods, and of proper sizes required by hangers according to the following

schedule.

3. Copper coated hangers and clamps shall be used to support non-insulated copper and brass pipe.
4. All pipe hangers shall be large enough to permit insulation to pass through hanger and rest upon protection plate without cutting insulation.

C. Hanger Rods.

1. Provide steel hanger rods (threaded both ends) (of all threaded type).
2. Hanger rods shall be as follows:

<u>Pipe Size</u>	<u>Hanger Rod Diameter</u>
2" or smaller	3/8"
2-1/2", 3", 3-1/2"	1/2"

D. Trapeze and Other Special Hangers.

1. Use approved trapeze and other special hangers, supports and anchors where shown or required. Trapeze type hanger shall be spaced in accordance with hanger spacing schedule for the smallest line.

E. Wall Support.

1. Pipe sizes to 3 inches steel hook like Elcen Fig. 46.

F. Vertical Support.

1. Steel riser clamp like Elcen Figure 39.

2.03 SLEEVES, INSERTS AND ANCHOR BOLTS

A. When pipes pass through all walls, roofs, ceilings or floors, they are to be surrounded by sleeves and sealed against water, air and smoke penetration.

1. Sleeves shall be large enough to permit pipe insulation to extend unbroken through the sleeve.
2. Sleeves for piping shall be made out of Schedule 40 steel pipe and shall be sealed against water, air and smoke penetration with a foamed in place U.L. rate fire resistant foam sealer meeting ASTM E119-76. Sealer shall be Dow Corning 3-6548 silicone RTV foam or General Electric Co. RTV silicone foam compound RTV 850 or RTV 6428.
3. Sleeves through outside walls shall be schedule 80, black steel pipe with a 150 lb. black steel slip on welding flange welded at the face of the sleeve and shall be painted with one coat of bitumastic paint. The space between the sleeve and the pipe shall be packed with Oakum to within 2" of each face of the wall. The remaining space shall be packed and made watertight with epoxy.
4. A sealing element made of synthetic rubber material suitable for a temperature range of -40° to 250° may be used. Sealing element shall be Thunderline Corp. "LINK-SEAL", or approved equal.

5. Sealing element for interior pipe sleeves shall be U.L. classified as a wall opening protective device and shall be a foamed in place fire resistant silicone foam sealant which remains pliable after application and curing. Sealing element shall be Dow Corning silicone RTV foam or General Electric Co. RTV silicone rubber compound.
6. The necessary sleeves, inserts and anchor bolts shall be set in place when the new floors, pads, walls, etc., are constructed. Coordinate with the appropriate trades to insure proper location and size for installation. Any omissions shall be the full responsibility of this trade.
7. Where piping penetrates existing solid core construction, they shall not require sleeves unless the structural integrity of the penetrated surface is jeopardized. Where mechanical systems dictate the need of installing sleeves, inserts, and anchor bolts, the holes are to be carefully cut and shall not be larger than necessary to permit installation. The masonry work and/or plastering must be carefully repaired at the expense of the trade requiring the sleeves. Core drilling is the responsibility of this trade.
8. Where piping penetrates existing solid core construction, they shall not require sleeves unless the structural integrity of the penetrated surface is jeopardized. Where mechanical systems dictate the need of installing hangers or brackets securely attached to building framing where building structural members are not available for support of pipes and equipment, in order to provide adequate bracing and hanger support. Proposed details on auxiliary supporting member shall be submitted to the Engineer for his approval prior to erection.

PART 3 - EXECUTION

3.01 Hanger Spacing.

- A. Hanger spacing shall be in accordance with the BOCA Plumbing Code, recommendations of the pipe manufacturer, or the following schedule, the more stringent requirement to apply. Provide at least one hanger on each branch line.

<u>Pipe Size</u>	<u>Maximum Space Between Hangers</u>
1/2", 3/4", 1"	6'
1-1/4", 1-1/2", 2", 2-1/2"	10'

- B. All Hangers shall be double-nutted, and protected from vibrating loose with lock washers and/or by having a lock-tite thread adhesive applied to the threads before assembling.
- C. All clips, hangers, supports sleeves and other attachments to the fireproofing bases are to be placed prior to the application of the fireproofing material where these attachments can be anticipated in advance.
- D. Piping, conduit or other suspended equipment, that could interfere with the uniform application of the fireproofing material, are to be positioned after the application of the fireproofing.
- E. All patching and repairing of fireproofing materials, due to cutting for attachments not anticipated in advance, shall be performed by a qualified and experienced fireproofing applicator as a part of this section of the

Specifications.

- F. Piping shall not be suspended from other piping. Only individual, Unistrut, or trapeze style hanging systems will be permitted

END OF SECTION

SECTION 15100

VALVES

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 15060 - Pipe and Pipe Fittings.

1.02 DESCRIPTION OF WORK

A. Drawings and General Requirements of Contract including General and Supplementary Conditions and Division 1 specification sections apply to work of this section. Extent of valves required by this section is indicated on drawings and/or specified in other Division 15 sections. Valves furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 15 sections.

1.03 STORAGE

A. Valves must be kept clean and dry prior to installation.

1.04 QUALITY ASSURANCE

A. Valve bodies and internals, including seating surfaces, must be suitable for the respective system pressures involved and in accordance with the latest editions of the appropriate ASTM and MSS requirements.

Valve Rating Line Pressures

PSI	PSI
250	thru 150

1.05 SUBMITTALS

A. Shop drawings shall be required for each style or valve to be installed on the Project.

1. Product Data - Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of valve.
2. Include pressure drop curve or chart for each type and size of valve.
3. Maintenance Data - Submit maintenance data and spare parts list for each type of valve. Include this data in Maintenance Manual.

1.06 GENERAL

11/08

- A. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All valves used on this entire project shall be as manufactured by the following, except valves intended for specialty purposes and specified as such. All valves of the same use and function shall be from one manufacturer.

- | | |
|--------------------|--------------|
| 1. American Valve. | 6. Nibco. |
| 2. Red-White. | 7. Keystone. |
| 3. Stockham. | 8. Apollo. |
| 4. Milwaukee. | 9. Crane. |
| 5. Metraflex. | |

2.02 PLUMBING VALVES

- A. General service valves for domestic hot and cold water services shall be either soldered end or threaded as dictated by the piping materials. Comply with the following standards:

- 1. Bronze Valves: MSS SP - 80.

- B. Shut-Off Valves. Packing - Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.

- 1. Valves two inches and smaller shall be ASTM-B62 all bronze, solder end, rising stem, screwed bonnet type gate valves with malleable iron handwheels or shall be ASTM-B62 all bronze, threaded, rising stem, screened bonnet type gate valves with malleable iron handwheels. Ball valves like those specified for HVAC shut-off valve water systems shall be acceptable. All solder end ball valves shall have 3-piece bodies.
- 2. Valves 2-1/2" and larger shall be ASTM-A126 Class B, iron body, flanged, rising stem, bolted bonnet, solid wedge disc, OS&Y with malleable iron handwheels. Flanged ball valves shall be acceptable.

C. Globe and Angle Valves. Packing - Select valves equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower.

1. Composition Discs - Where required, provide suitable material for intended service.
2. Comply with the following standards:
 - a. Cast-Iron Valves: MSS SP - 85
 - b. Bronze Valves: MSS SP - 80
3. Valves two inches and smaller shall be ASTM B-62 all bronze, solder ends, rising stem, screwed bonnet type globe or angle valves with malleable iron handwheels, or equal valve for threaded joint pipe.
4. Valves 2-1/2" and larger shall be ASTM A-126 Class B, iron body, flanged, rising stem OS&Y, bolted bonnet, renewable bronze seat and disc with malleable iron handwheels.

D. Check Valves.

1. General - Construct pressure containing parts of Valves as follows:
 - a. Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62
 - b. Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing:
 - a. Bronze Valves: MSS SP - 80
 - b. Cast Iron Valves: MSS SP - 71
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Valves two inches and smaller shall be ASTM B-62 bronze, swing check design, screwed cap, bronze disc with threaded or solder ends as required.
5. Valves 2-1/2" and larger and used on sewage or storm water pump discharge shall be flanged horizontal swing type. Valve shall have an iron body and a bronze mounted disc. Valve to have a non-shock cold water rating of 175 PSI or greater.

E. Gas Cocks.

1. Cocks 2" and smaller shall be bronze plug cocks with retainer nut, lever operated and threaded ends.
2. Cocks 2-1/2" and larger shall be iron body plug cocks with iron trim, flanged, square wrench head and iron washer.

F. Wall Hydrants (Freeze-proof)

- a. Shall be exposed automatic draining freezeless wall hydrants like Woodford Model 60 series or approved equal by Mifab, Wade or Josam. With 3/4" hose threaded nozzle, vacuum breaker, one piece valve plunger to control both flow and drain functions, hardened stainless steel operating stem, chrome finish on brass castings. Loose tee key to be furnished with each hydrant. Hydrant shall be located twenty four inches (24") above finish grade.

G. Hose Bibbs (Interior Use)

- a. Shall be exposed wall faucet like Woodford Model 24 series or approved equal by Mifab, Wade or Josam. With 3/4" hose threaded nozzle, anti-siphon vacuum breaker, one piece valve plunger to control both flow and drain functions, brass construction and finish. Handle to be wheel type made of polycarbonate. Provide faucet with inlet size as shown on Drawings and/or details

F. Valve Features. General - Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.

1. Flanged - Valve flanged comply to ANSI B16.1 (cast iron), ANSI B16.5(steel), ANSI B16.24 (bronze).
2. Threaded - Valve Ends complying with ANSI B2.1.
3. Butt-Weld - Valve Ends complying with ANSI B16.25.
4. Solder Joint - Valve Ends complying with ANSI B16.18.
5. Flangeless - Not Acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION OF VALVES

A. Install valves in the following locations and of the types indicated in the schedules.

1. Wherever indicated on the drawings.
2. Shut-off valves in the inlet and outlet connections of each piece of equipment.

3. Immediately upstream of dielectric unions.
 4. On each branch line near the main when the branch line serves two or more fixtures or devices.
- B. Locate valves accessibly and arrange to permit easy removal of fixtures and equipment they serve.
 - C. Unless otherwise noted, all valves shall be full size of the lines in which they are mounted.
 - D. Do not mount valves with the stem and bonnet pointed below a horizontal position.
 - E. Provide ball pattern valve for draining the low points in water lines.
 - F. Install all valves with all plugs in the open position. Close only when assured that the sealing parts are free from foreign materials. Weld scale, or similar foreign materials found embedded in sealing surfaces, will require the installation of new trim or complete valve.
 - G. Provide balancing valves for throttling purposes at all branches of the domestic water recirculating line..
 - H. Mount all globe valves to close against flow pressure. Flow should be against the bottom of the plug.
 - I. Install automatic valves supplied under Sections 15900 through 15970.
 - J. Use screwed pattern valves for threaded joint pipe. Use sweat end valves for soldered joint pipe. Use flanged valves for welded joint pipe.
 1. Soldered valves must be installed with internal parts removed. Do not overheat. Install internals only after body has cooled and been cleaned.
 - K. All valves must be fully accessible. Provide access panels and doors where valves are installed in inaccessible areas or as need; and as specified in Section 15022.
 - L. All relief valves shall be so installed that no type of shut-off or restriction is located between the relief valve and the pressure vessel or other device needing relief protection.
 - M. All safety valve discharge piping shall be extended to within 2" of the floor and/or in the Machine Room, to a floor drain or mop sump, or as shown on drawings, to prevent damage to furnishing and injury to personnel.

- N. In no case shall a relief valve be installed in or on a system in which any component has a pressure rating less than that of the relief valve.
- O. Applications Subject to Shock - Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
- P. Installation of Check Valves
1. Swing Check Valves - Install in horizontal position, unless otherwise shown on drawings, with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.
- Q. All relief valves shall be so installed that no type of shut-off or restriction is located between the relief valve and the pressure vessel or other device needing relief protection.
- R. Waterfill and pressure reducing valves shall be installed with a three-valve bypass. The bypass line shall be one pipe size smaller than the reduced main unless indicated otherwise and shall have a balancing valve and check valve. Final set pressure of the valve shall be determined by testing the installed system pressure with the system filled to its highest water main. Valve shall be set at system pressure plus 5 PSIG.
1. Install pressure reducing valve according to manufacturer's recommendations.
 2. Install a "Y" type non-clog strainer at the inlet to each valve and pipe with a hose-end blow-off valve.
- S. Valves installed in conjunction with chemically treated systems, i.e. make-up water lines to heating water, chilled water systems, etc., shall be installed with a reduced pressure principal backflow device in the supply line to prevent backflow contamination.

END OF SECTION

SECTION 15161

VIBRATION ISOLATION

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 15010 - General Provisions

1. Seismic Restraints

B. 15094 - Hangers and Supports.

C. Section 15164 - Flexible Connectors.

1.02 SUBMITTALS

A. Samples: The contractor shall submit samples in triplicate of all vibration isolation devices offered as substitutions to those specified. The contractor shall also submit samples of specified isolation devices upon request to the engineer for approval.

B. Shop drawings shall be required on each style or type of isolator to be installed on the Project. The contractor shall have prepared by the isolation materials manufacturer, and shall submit to the engineer for approval, drawings showing the construction of the isolation devices to be used, including specific selection of isolators for the equipment to be furnished for this project, and shall include the complete design of supplementary bases; a tabulation of the design data for each isolator, including spring O.D., free operating, and solid heights, and ratio of horizontal to vertical stiffnesses, and other required data to clearly indicate that the specified isolator types and minimum static deflections are provided by the system submitted.

1.03 MATERIALS AND INSTALLATION

A. The materials and systems specified in this section shall be purchased from a single vibration isolation materials manufacturer to assure single source responsibility for the performance of isolation materials used.

B. Installation of all vibration isolation materials specified herein shall be accomplished following the manufacturer's written instructions. Installation instructions shall be submitted to the engineer for approval prior to beginning the work.

1.04 DESCRIPTION OF SYSTEM

A. The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of noise and vibration isolation devices and systems as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications.

This work in general shall include but not necessarily be limited to the following:

1. All mechanical and electrical equipment shall be isolated from the building structure by means of noise and vibration isolators.

2. All piping over 1" outside diameter located in mechanical equipment rooms, and for a minimum of

- fifty (50) feet or 100 pipe diameters, whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers. All piping in the building which is connected to vibration isolated equipment shall be isolated at connections to the building structure.
3. All ductwork located in mechanical equipment rooms, and for a minimum of fifty (50) feet from any connection to vibration isolated air moving equipment shall be isolated from the building structure by means of noise and vibration isolation hangers.
 4. All piping and ductwork vertical risers shall be isolated from the building structure by means of noise and vibration isolation guides and supports.
 5. All piping and ductwork to be isolated according to this section of the specification shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain a minimum of 3/4" and maximum of 1 1/4" clearance around the outside surfaces. This clearance space shall be tightly packed with 1.58 P.C.F. glass fiber and shall be caulked airtight after installation of the piping or ductwork.

1.05 SYSTEM DESIGN

- A. The isolation materials manufacturer shall be responsible for the proper selection of isolators to accomplish the specified minimum static deflections, for all isolators, based on the actual weight distribution of equipment to be isolated.
- B. The isolation materials manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases, to support mechanical equipment scheduled to receive such supplementary base.
- C. The contractor shall furnish a complete set of approved shop drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation materials manufacturer, based upon which the selection of vibration isolators and design of supplementary bases will be completed. The shop drawings to be furnished shall include operating weights of the equipment to be isolated and the distribution of weight at support points.
- D. The contractor shall furnish a complete layout of piping and ductwork to be isolated, including vertical risers, showing size or weight and support points of the piping or ductwork system, to the vibration isolation materials manufacturer, for selection and layout of isolation hangers.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Consolidated Kinetics.
- B. Amber-Booth.
- C. Vibration Eliminators, Inc.
- D. Mason Industries.
- E. Korfund Dynamics Corporation.

F. Rubatex.

2.02 SPRING HANGERS

- A. Provide double overlap steel housed spring type hanger isolators having rubber in shear top bumpers where shown on ceiling-hung, vibrating devices, or required by the nature of the work. Hangers to be Amber-Booth Type BSS or approved equal.

2.03 ISOLATOR PADS

- A. Isolator pads shall be neoprene in compression type, having a steel load plate bonded to a double ribbed neoprene pad. Pads shall be Amber Booth type "NR" or approved equal.

2.04 VIBRATION ISOLATORS

- A. Isolators for small equipment (150 lbs. or less) shall be rubber in shear type designed for high static deflection and high compression loading. They shall be one piece neoprene rubber double deflection acoustical elements with steel reinforcing.
- B. Isolators shall be Amber Booth Type "RV" or approved equal.

2.05 FLOOR MOUNTS

- A. An adjustable, free-standing, open-spring mounting with combination leveling and equipment fastening bolt. The spring shall be welded to the spring mounting baseplate and compression plate for stability. The isolator shall be designed for a minimum K_x/K_y (horizontal-to-vertical spring rate) of 1.0. An elastomeric pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Nuts, adjusting bolts and washers shall be bonded to the baseplate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion. Isolators shall be Amber-Booth type "SW" or approved equal.

2.06 SPRING ISOLATED SUSPENDED EQUIPMENT, PIPING, DUCTWORK

- A. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. Vibration isolation hangers shall be like Mason 30N Series or Amber Booth BSR Series or an approved equal.
- B. Vibration isolators for suspended equipment with minimum static deflection requirement exceeding .4", and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a precompressed molded fiberglass insert, complete with load transfer plates and assembled in a stamped or welded steel bracket.

PART 3 - EXECUTION

3.01 SYMPATHETIC VIBRATION

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- A. Reposition or restrain the positions of pipe hangers, dampers, etc., to counteract any sympathetic vibrations which may be set by job conditions as directed by the Engineer or Owner.

3.02 INSTALLATION

- A. Isolation to be properly sized to remove 97% of source vibration. All vibration and noise isolators shall be by one manufacturer.
- B. Provide vibration isolation for all suspended operating equipment, such as fans, pumps, air handlers, fan and coil units, etc., which could transmit vibration to the structure.
- C. On completion of installation of all isolation materials and before start-up of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.
- D. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

3.03 INSPECTION

- A. The contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.
- B. The local representative of the vibration isolation materials manufacturer shall conduct periodic inspections of the installation of materials herein specified, and shall report in writing to the contractor any deviations from good installation practice observed.
- C. On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.
- D. The installing contractor shall submit a report to the architect, including the manufacturer representative's final report, indicating all isolation material is properly installed or steps to be taken by the contractor to properly complete the isolation work as per specification.

END OF SECTION

SECTION 15170

METERS AND GAGES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each style or type of pressure gage, thermometer, test plug or gage glass to be installed on the Project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Ashcroft.
- B. Trerice.
- C. Weksler.
- D. Lonergon.

2.02 PRESSURE GAGES

- A. All gages shall have 4-1/2" diameter dials, and have bronze mechanisms mounted in cast iron, or cast aluminum cases with cast brass rings. Each gage connection shall be orificed to prevent pulsation. Gages shall be provided with a shut-off cock. They shall be suitably calibrated so that the normal operating points of systems are at mid-scale. Each gage shall show its calibration units; i.e., - PSI, in Hg., ft. of H₂O, etc.

2.03 THERMOMETERS

- A. Thermometers are to be Industrial 9" mercury filled tube type, adjustable angle and complete with brass well, length suitable for piping system. Thermometers are to be accurate within 1% of scale range. Scale shall be black embossed numerals on a white background. Red mercury tube shall be protected by clear acrylic plexiglass lenses. Scale ranges are to be selected to read in the middle of the range at normal operating conditions.

2.04 THERMOMETER WELLS

- A. At all exits and entrances to equipment where thermometers are installed, there shall be a well provided.
- B. Thermometer wells shall be the same manufacturer as thermometers.

PART 3 - EXECUTION

3.01 THERMOMETER WELLS

- A. When thermometer wells are installed in lines 2" and smaller and wells cannot be installed at pipe

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direction changes, increase pipe size one size or such that the velocity of the fluid at the well section is not increased.

3.02 THERMOMETERS

- A. Thermometers shall be installed where shown on the plans and inlet and outlet of boiler, heat exchangers and all other points of calibrated heat change.

3.03 PRESSURE GAGES

- A. The pressure gages shall be installed where shown on the Drawings and be graduated so that normal operating point is at mid-scale. They shall be mounted remote if need be, for convenience of reading.
- B. Pressure gages shall be installed at suction and discharge of all heat exchangers, all pumps and elsewhere as shown on the Drawings.

3.04 VISIBILITY

- A. All thermometers and pressure gages shall be located and mounted such that they may be easily read while standing on the floor or normal work platform. Multi-angle and/or remote reading thermometers shall be used where necessary to make this possible.

END OF SECTION

SECTION 15250

PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15060 - Pipe and Pipe Fittings.

1.02 SYSTEM DESCRIPTIONS

- A. Provide insulation to all hot and cold surfaces. Hot surfaces shall be defined as surfaces above 100°F; Cold surfaces shall be surfaces below 60°F.
- B. These surfaces chiefly include the following, but are not limited to:
 - 1. Domestic Hot and Cold Water
 - 2. Refrigeration condensate drains.
 - 3. Refrigerant Suction; and Accessable Hot Gas Lines below 7' above floor level.
 - 4. Horizontal Roof Leaders and Drains.
 - 5. Miscellaneous cold surfaces not insulated by equipment manufacturer.
 - 6. Heating and cooling lines.

1.03 SUBMITTALS

- A. Shop drawings and product data shall be required on all jackets, coverings, adhesives, sealants, cements and other materials used for installation in this section.
- B. Provide submittals on field fabricated cover for piping specialties.

1.04 REFERENCES

- A. The following standards of the issues listed below form a part of this specification to the extent indicated by the references made to:
 - 1. American Society of Testing Materials (ASTM).
 - 2. Underwriters' Laboratories (UL).

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manville
- B. Rubatex
- C. Upjohn
- D. Armstrong
World Industries, Inc.
- E. Pittsburg-Corning
- F. Knauf
- G. Owens-Corning

2.02 MATERIALS

A. Coverings

1. 4# density fiberglass premolded. The jacket shall consist of a fire retardant all-temperature vapor barrier type bonded together with a self-extinguishing adhesive. The cover and jacket shall have a flame spread of 25 or less and a smoke development of 50 or less and so be rated by UL. Insulation shall have a "K" factor no greater than .23 at 75°F mean temperature.
2. Elastomeric closed cell pipe and sheet insulation. Minimum 5.5 lb/ft³ density; thermal conductivity of 0.28 at 75°F; maximum 5.6% shrinkage at 200°F for 7 days; minimum 0.2 perm-in. water vapor permeability; maximum 4.8% by weight water absorption; self-extinguishing; flame spread of 25; smoke develop rating of 100 by ASTM E-84 test method. Insulation shall be in factory molded sections like Armstrong FR/Armaflex II with Armstrong 520 Adhesive.
3. Urethane - factory molded; closed cell construction; 0.16 maximum "K" factor at 75°F mean temperature; minimum 25 PSI compressive strength at 10% deflection; physically and chemically stable from -40°F to 220°F with vapor barrier jacket. Flame spread shall be 25, smoke develop shall be 50 like Upjohn's "CPR".
4. Hydrous Calcium Silicate - 13 lbs./cu. ft. density like Johns-Manville "Thermo-12" or equivalent have "K" of .40 at 200°F mean temperature and UL listed fire retardant jacket.

- B. Fittings shall be covered with fiberglass wrap or mitered pipe covering to a thickness and density equal to adjoining pipe covering and covered with premolded PVC fitting covers as manufactured by Ceel-Co, Zeston Industries, or approved equal.

C. Exposed Piping

1. Outdoor water (not buried) piping shall have a protective system consisting of premolded urethane insulation having a "K" factor of .16 at 75°F mean temperature with clearance for electric cable wrapped on the pipe. Insulation shall have a weatherproof jacket of .016" aluminum sheeting premolded and joined with a snap-on strap of plastic sealing compound banded into place.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Insure piping has been tested, proven tight, thoroughly cleaned and that there is no evidence of leakage before installing covering. Protect equipment and other uncovered piping from dirt and rubbish which may be caused by installation by means of tarpaulins or other coverings. Check environmental conditions to insure that they are within manufacturer's recommendations for sealants, tapes and other adhesives to be used before application.

3.02 INSTALLATION

- A. Insulation shall be lap sealed using adhesive or staples.

1. On cold systems, adhesive shall be water-proof and staples or other penetration of the vapor barrier will be permitted when covered with water-proof adhesive or tape.
2. On hot systems where staples are used, they will be covered with tape and butt strips of the same material as the jacket to provide a smooth surface.

3. All installations shall be per manufacturer's best written instructions.
 4. All installations shall be installed by qualified insulation mechanics.
- B. All insulation shall be installed over clean, dry surfaces with adjoining sections firmly butted together and covering all surfaces. Voids and holes are to be properly filled and all raw edges properly sealed.
- C. Fittings, valve bodies, flanges, unions, pumps, etc. shall be covered with a compressed in place, mitered pipe covering, or custom manufactured insulation products to a density and thickness equal to the adjoining pipe covering and finished with a manufactured PVC covering.
1. On water lines, valves, fittings, flanges, unions and other specialties requiring periodic removal shall be insulated.
 2. On cold systems where standard maintenance requires periodic removal such as plate & frame heat exchangers, strainers, caps, flanges, unions, etc., they shall be insulated to allow service of parts. The insulation shall be built so that it may be slip removed and reinstalled using vapor barrier tape and cement.
- D. Where insulation is applied on pipes which are against walls, columns or other equipment without adequate space for insulation, provide a means for finishing the insulation on a neat workmanlike manner to meet approval of Engineer.

3.03 SCHEDULE

- A. Insulation shall be applied to piping systems in minimum thicknesses shown in the following schedule. Contractor may use two or more layers to get thickness called for.

K @ 75° Mean	Fiberglass K = .23	Elastomeric Foam K = .28	Urethane K = .16	Foamglas and Hydrous Calcium Silicate K = .38
<u>Domestic Hot Water piping</u> (100°F to 140°F)				
Less than 1"	1"	1"	1"	1-1/2"
4" to 1"	1-1/2"	1"		
<u>Domestic Cold Water piping</u>				
All Piping	3/4"	3/4"		
<u>Cooling Coil Condensate. (In Mechanical Room and Concealed Applications)</u>				
	1"	1"	1"	

Low Temperature Refrigerant / Condensate and Heating/Cooling piping

1"

Horizontal Roof Drains
And Drain Pans

1-1/2"

1"

3.06 INSULATION IN RETURN AIR PLENUM

A. All insulation shall have a 25 flame spread and smoke development of 50 or less in return air plenums.

3.07 INSULATION OUTSIDE

A. Elastomeric foam shall be painted, or otherwise coated, with U.V. inhibited coating.

END OF SECTION

SECTION 15258

EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15848 - Duct Lining.

1.02 SUBMITTALS

- A. Shop drawings shall be required on all jackets, covering, adhesives, sealants and cements to be installed on the Project.

1.03 SYSTEM DESCRIPTION

- A. It is the intent of this project for ductwork to be insulated, either internally or externally. The Contractor shall bring any discrepancies or conflicts listed or shown in the Specifications and/or drawings to the Engineer's attention prior to bidding the project. Failure to do so shall not be grounds for additional costs towards the Owner or Engineer, for a fully insulated project.

PART 2 - PRODUCTS

2.01 DUCT INSULATION

- A. External duct insulation shall be 1-1/2" thick, 1-1/2 lb. density fiberglass faced with a .002" thick aluminum facing or lightweight foil skim, and shall be vaporproof and fireproof. Insulation shall have a maximum K factor of .27 at 50°F mean temperature.

2.02 ACCEPTABLE MANUFACTURERS

- A. Manville Co.
- B. Owens-Corning Co.
- C. Certainteed.
- D. Knauf.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Insulation shall be glued and pinned to ductwork with fireproof adhesive so that there is no sagging and no vapor barrier penetration. All joints shall have 1-1/2" minimum lap and shall be taped with fireproof adhesives. Adhesives shall be applied so as to attain no less than 50% contact coverage of all sheet metal surfaces. In general, the insulation shall be installed as shown in the SMACNA low Velocity Duct Manual, and shall be internal or external where specified or noted on the drawings and as follows:
 1. Supply, outside and mixed air duct, outside air dampers, and blankoff plates, shall be insulated externally. .
 2. Exhaust and return ductwork shall not be insulated, unless noted otherwise.

END OF SECTION

SECTION 15310

FIRE PROTECTION PIPING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Pipe, fittings, valves, and connections for fire protection systems.

1.02 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTION.

- A. None.

1.03 RELATED WORK

- A. Section 15330 - Automatic Fire protection System.

1.04 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- C. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- D. NFPA 13 - Installation of Sprinkler Systems.

1.05 QUALITY ASSURANCE

- A. Conform to NFPA 13 for sprinkler systems.
- B. Welding Materials and Procedures: Conform to ASME Code.
- C. Employ certified welders in accordance with ANSI/ASME Section 9.
- D. Valves: Bear UL FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.06 SUBMITTALS

- A. Submit product data under provisions of Section 15013.

B. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals.

C. Indicate valve data, operators, and ratings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place, under provisions of Section 01600.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures. Maintain in place until installation.

PART 2 -PRODUCTS

2.01 PIPE AND TUBE

A. Steel pipe: Schedule 10 or 20, ASTM 120, black; as permitted by NFPA 13.

2.02 PIPE FITTINGS

A. Steel Fittings: ANSI/ASME B16.9, wrought steel, buttwelded.

B. Ductile Iron Fittings: ANSI/AWWA C110.

2.03 UNIONS, FLANGES, AND COUPLINGS

A. Unions: 150 psi malleable iron for threaded ferrous.

B. Flanges: 150 psi forged steel slip-on flanges for ferrous piping.

C. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; AC@shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.

2.04 ACCEPTABLE MANUFACTURERS - VALVES

- A. Grinnel.
- B. Viking.
- C. Star Sprinkler Corporation.

2.05 GATE VALVES - Iron body, bronze trim, rising stem, OS&Y, solid wedge, manufactured by Grinnel.

2.06 GLOBE OR ANGLE VALVES - Iron body, bronze trim, rising stem, OS&Y, renewable composition disc.

2.07 CHECK VALVES - Iron body, bronze trim, swing disc, renewable disc and seat.

2.08 BUTTERFLY VALVES - Iron body, bronze disc and stem extended for insulated work, resilient replaceable liner seat.

2.09 DRAIN VALVES - Bronze compression stop with nipple and cap or hose thread.

2.10 VALVE OPERATORS

- A. Provide handwheels for gate, globe or angle, and drain valves.
- B. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes provide level lock handle with toothed plate.
- C. For valves located more than 7 feet from floor in equipment room areas, provide endless chain operated sheaves. Extend chains to 5 feet above floor and secure clear of walkways.

2.11 VALVE CONNECTIONS

- A. Provide valve connections to match pipe joints. Use valves of pipe size.
- B. Provide butterfly valve with tapped lug body when used for isolating service.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends to full inside diameter.
- B. Remove burrs and bevel plain end ferrous pipe.

C. Remove scale and foreign material, inside and outside, before assembly.

3.02 INSTALLATION - PIPE

A. Screw joint steel piping up to and including 1 1/2 inch diameter. Screw or weld 2 inch diameter piping. Weld piping 2-1/2 diameter and larger, including branch connections.

B. Mechanical grooved joints may be used instead of threaded or welded joints. (Existing system is "Victaulic".)

C. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

D. Coat threaded ends with pipe lubricant compound.

E. In steel piping, main sized saddle branch connections or direct connection of branch lines to mains is permitted if main is one pipe size larger than the branch for up to 6 inch mains and if main is two pipe sizes larger than branch for 8 inch and larger mains. Do not project branch pipes inside the main pipe.

F. Install piping in accordance with NFPA 13 sprinkler systems.

G. Do not penetrate building structural members unless indicated.

H. Provide sleeves when penetrating footings, floors and walls.

I. Seal pipe and sleeve penetration to achieve fire resistance equivalent to fire separation required.

3.03 INSTALLATION - VALVES

A. Install valves with stems upright or horizontal, not inverted.

B. Provide gate valves for shut-off or isolating service.

C. Where approved, butterfly valves may be used instead of gate valves.

D. Provide drain valves at shut-off valves, low points of piping and apparatus.

END OF SECTION

SECTION 15330

AUTOMATIC FIRE PROTECTION

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION AND WORK INCLUDED (But Not Limited To)

- A. Design and a new service to project Area as stated herein and/or indicated on the drawings, designed for intended use.
- B. Interface system with building fire alarm control system(s) and building fire and smoke alarm system(s), as required and/or as shown on the drawings.
- C. Provide system to NFPA 13 requirements.
- D. Pump(s) (when required).

1.02 WORK INSTALLED BUT FURNISHED UNDER OTHER SECTIONS

- A. Section 15310 - Fire Protection Piping: Piping and valves.

1.03 RELATED WORK

- A. Section 15013 - Submittals & Substitutions.
- B. Section 15014 - Project Coordination.
- C. Section 15047 - Identification.
- D. Section 15060 - Piping and Pipe Fittings.
- E. Section 15094 - Hangers and Supports.

1.04 REFERENCES (Most current edition.)

- A. NFPA 13 - Installation of Sprinkler systems.
- B. NFPA/UL 448 - Pumps for Fire Protection Service.

1.05 QUALITY ASSURANCE

- A. Design and installation to conform to NFPA 13.

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B. Equipment and Components: Bear UL and FM label or marking.

C. Specialist Firm: Company specializing in sprinkler systems with three years experience.

D. Provide pumps with manufacturer's name, model number, and rating/capacity, (if applicable).

E. Perform pump testing under provisions of Section 01400, (if applicable).

F. Test pump, driver, and controller in accordance with NFPA 20, (if applicable).

1.06 REGULATORY REQUIREMENTS

A. Hydraulic Calculations, Product Data, Shop Drawings, and Low Water Pressure Cut-in Controller: Bear stamp of approval of Fire Marshall and Owner's fire insurance underwriter.

1.07 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 15013.

B. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories.

C. Submit shop drawings hydraulic calculations to authority having jurisdiction fire Marshall Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 01720.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's operation and maintenance data under provisions of Section

01730.

- B. Include written maintenance data on components of system, servicing requirements, and Record Drawings.
- C. Include pump operation, maintenance, and inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store pumps in shipping containers with labeling in place under provisions of Section 01500.
- B. Provide temporary inlet and outlet caps.
- C. Maintain caps in place until installation.

1.11 EXTRA STOCK

- A. Provide extra sprinkler heads under provisions of NFPA 13 and Section 01700.
- B. Provide suitable wrenches for each head type.
- C. Provide metal storage cabinet in location designated.
- D. Provide one set of gaskets for each pump type and model supplied for Owner=s use.

PART 2 -PRODUCTS

2.01 PIPING MATERIALS

- A. Buried Piping: Cast Iron.
- B. As specified in Section 15310.

2.02 ACCEPTABLE MANUFACTURERS - SPRINKLER HEADS

- A. Grinnel.
- B. Viking.
- C. Star Sprinkler Corporation.

- D. Reliable.
- E. Gem.
- F. Central.
- G. Substitutions: under provision of General Conditions.

2.03 SPRINKLER HEADS

- A. Sprinkler head shall be a sidewall or semi-recessed (as applicable per code), glass bulb automatic sprinkler, 1/2" orifice, 5.6 K-Factor, 155° F temperature rating, 175 psi maximum working pressure, U.L. and U.L.C. approved and labeled; like Tyco TY-B. Sprinkler and escutcheon shall be white or off-white as selected by Architect.
- B. Fusible Link: Temperature rated for specific area hazard, verify.

2.04 PUMP CONSTRUCTION - As Required

- A. Statically and dynamically balance rotating parts.
- B. Construction to permit complete servicing without breaking pipe or motor connections.
- C. Pumps to operate at 1,750 rev/min.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. System shall be installed according to the requirements of the Authority having jurisdiction.
- B. All heads will be centered in ceiling tiles where applicable. Architect will have final approval for head locations in areas, which may or may not require extra heads.
- C. ***Due to limited space for piping installation, contractor is to coordinate with work of other trades before installing sprinkler pipe. Other work is to include, but not necessarily be limited to, lighting, electrical conduit, computer cabling, ductwork, and plumbing.***

END OF SECTION

SECTION 15401

DOMESTIC WATER SUPPLY
AND TREATMENT

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15060 - Pipe and Pipe Fitting.
- B. Section 15100 - Valves.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. See Material Schedule in Section 15060.

PART 3 - EXECUTION

3.01 SYSTEM INSTALLATION

- A. The entire system of hot and cold water piping throughout the project shall be installed so that it may be shut off and drained completely to suitable points at floor drains.

3.02 DISINFECTION OF WATER PIPING

- A. Before water system is turned over for use, this trade shall disinfect the entire system. Disinfection shall be by the introduction of a hypochlorite solution suitable for the intended purpose. System shall stand in the piping for 8 hours, with suitable warning signs posted at each water outlet.
- B. After disinfection and final flushing, several samples at the ends of lines shall be drawn and tested by the State Board of Health, local health authority or an independent laboratory approved by the Board of Health.

3.03 ROUGH-IN

- A. Provide rough-in and final connection as indicated on the contract drawings. Contractor shall coordinate with equipment suppliers for all rough-in requirements.

END OF SECTION

SECTION 15420

PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 07900 - Joint Sealants.
- B. Section 15060 - Pipe and Pipe Fittings.
- C. Section 15080 - Piping Specialties.
- D. Section 15100 - Valves.

1.02 SUBMITTALS

- A. Shop drawings showing fixtures, trim, rough-in data and all accessories shall be required on each type of fixture to be installed on the Project.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES

- A. All china plumbing fixtures shall be American Standard, Kohler, Crane, Eljer or an approved equal; as scheduled on Drawings. All stainless steel plumbing fixtures shall be Elkay, Dayton, Just, or an approved equal. Water fountains or electric coolers shall be Oasis, Elkay, Halsey-Taylor or an approved equal. Mop or floor sinks shall be Fiat, Mustee, or approved equal. Where plate numbers are specified, the fixtures shall be complete as described in the catalog referenced, with modifications as noted. Trim shall be as provided as specified, or by manufacturer or by Sanitary Dash
- B. All wall-hung fixtures shall be mounted on suitable fixture carriers as manufactured by J.R. Smith, Josam, Wade or Zurn, unless detailed otherwise.

PART 3 - EXECUTION

3.01 INSTALLATION OF FIXTURES

- A. The trade shall protect all fixtures from injury until final acceptance. Keep fixtures completely covered and all exposed pipes, fittings and faucets wrapped to prevent injury or scratching. Fixtures shall be absolutely guaranteed against any cracking or crazing of the finish. Whenever such a defect develops during the first year, this trade shall replace the defective fixture with a new and perfect one of the same manufacture without additional cost to the Owner.
- B. All fixtures, trim and supplies shall be set plumb and true to wall lines and securely held in place. This trade shall grind the fixture to proper fit if necessary to secure a perfect fit at walls or floors.
- C. The trade shall install all plumbing fixtures complete with all water, waste, and vent connections. The number of plumbing fixtures shall be checked by count from the drawings. Upon completion of the work and before final acceptance, all plumbing fixtures shall be thoroughly tested and found to be free from all imperfections.

- D. All wall-hung lavatories shall be supported by fixed or adjustable chair carriers as required. All chair carriers shall be provided with block base supports or with feet turned backward and bolted to the floor (using each available hole) in pipe spaces.

3.02 CONNECTIONS TO FIXTURES

- A. Each plumbing fixture or equipment item shown or implied shall be provided with all connections required (including piping, valves, unions, traps, stops, etc.). All pipes shall be connected to fixtures with chrome plated brass couplings or unions of such type that fixtures can be removed and reset without making new joints. Supply connections shall be made with ground joint unions and not with slip joints. 7/16" O.D. flexible risers will be permitted for lavatory and sink supply connections. All supply lines shall be securely held in place. An escutcheon finished to match the pipe shall be used around waster and supply piping wherever same passes through the floor, wall or ceiling.

3.03 CLEANING FIXTURES

- A. Upon completion of installation, all trade labels shall be removed and all fixtures shall be thoroughly cleaned. The fixtures shall be thoroughly cleaned a second time immediately before turning them over to the Owner.

3.04 CHROME PLATED WORK

- A. All exposed metal parts on all plumbing fixtures and exposed pipe connections thereto shall be brass, heavily chrome plated. Nickel plated work will not be accepted.

3.05 AMERICANS WITH DISABILITIES ACT (ADA) REQUIREMENTS

- A. Padding shall be provided on all exposed hot and cold water valves and piping, and drain piping exposed below lavatories. Padding shall be a complete system like Handi Lav-Guard, as manufactured by Truebro and as represented by Aspinall, Inc, Indianapolis, Indiana. Color shall be painted to match wall. Handicapped restroom shall have a designated handicapped / ADA lavatory, which will require that water supply be tight to wall. Drain shall be offset 5" to wall before P-trap.
- B. Drinking fountains are to be piped giving clearances as designated in ADA Act. If Contractor is not aware of the ADA requirements, they can be obtained from the Engineer.

END OF SECTION

SECTION 15421

FLOOR DRAINS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each type of floor drain to be installed on the Project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

- A. Jay R. Smith.
- B. Josam.
- C. Wade.
- D. Zurn.

- 2.02 Provide floor drains where shown and scheduled on Drawings.

PART 3 - EXECUTION

3.01 DRAINS

- A. Drains shall be installed in the poured concrete and precast concrete floor slabs in accordance with the manufacturer's instructions. Drains shall be leveled with the finished floor. Drains cut into precast decks shall be sealed to prevent seepage outside the drain body. Slab cuts for installing drain shall be by this trade.

END OF SECTION

SECTION 15423

CLEANOUTS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each type of cleanout to be installed on the Project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. J.R.Smith.
- B. Josam.
- C. Wade.
- D. Zurn.

2.02 CLEANOUTS

- A. Floor cleanouts for tile areas to be J.R.Smith 4151 or approved equal, cast iron cleanout with adjustable threaded housing, bronze inner plug, lead seal and nickel bronze round frame.
- B. Floor cleanouts for finished concrete or terrazzo shall be J.R.Smith #4021, cast iron body with adjustable threaded housing, bronze inner plug, lead seal and cast iron round frame and scoriated nickel bronze top. Under carpet installation shall include TYPE "Y" carpet marker.
- C. Crawl space or concealed area cleanouts shall be J.R.Smith 4400 or 4405, or approved equal unit to be furnished with bronze plug and lead seal, less access plate and screw.

PART 3 - EXECUTION

3.01 CLEANOUTS

- A. Cleanout branches shall be provided throughout the inside plumbing system wherever required by the nature of the work. Provide cleanouts with brass cleanout screws at every turn and angle on all soil and waste piping, and in no case shall the distance between the cleanouts be over 100' in pipe 5" and larger and 50' in piping 4" and smaller.
- B. Under carpet installation shall have cleanout installed under carpet with marker button through carpet

END OF SECTION

SECTION 15424

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15060 - Pipe and Pipe Fittings.

1.02 SUBMITTALS

- A. Shop drawings shall be required on each type of heater, controller, mixing valve and circulator to be installed on the Project.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. See appropriate Sections for pipe, fittings, valves, specialties, etc.

2.02 ACCEPTABLE MANUFACTURERS

- A. Lochinvar.
- B. A.O.Smith.
- C. State Industries, Inc.
- D. Rheem

A. Bradford White

B. Patterson Kelly

2.03 GAS FIRED WATER HEATER

- C. Water heater shall be a boiler and storage tank system as scheduled on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Relief valve shall be extended to floor drain or mop sink.
- B. Water heaters shall be installed in full accordance with the manufacturer's written instructions. Install heater and connect to appropriate gas, cw & hw piping and flue. Provide drain valve.
- C. Verify with manufacturer type of flue required for all gas-fired water heater.

3.02 TESTING

11/08

- A. The hot domestic water systems shall be tested for 8 hours under a hydrostatic pressure of 100 psig. Test shall be considered satisfactory only if there is no loss in pressure in excess of 1/2 of 1% of the test pressure for the duration of the test.
- B. Where multiple units of equipment are provided with the intent of being manifolded together, all interconnecting piping, valve, fittings, meters, alarms, etc. shall be provided. Each unit shall be protected against backflow and shall be provided with a valve and union at each connection to enable servicing or isolation of any given unit.

END OF SECTION

SECTION 15660

AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each size and type of condensing unit to be installed on the Project.

1.02 RELATED SECTIONS

- A. SECTION 15060 - PIPE AND PIPE FITTINGS
- B. SECTION 15250 - PIPING AND EQUIPMENT INSULATION

PART 2 - PRODUCTS

2.01 AIR COOLED CONDENSING UNITS

- A. Provide air cooled condensing units, as scheduled on drawings, in the location and manner shown on the drawings. The units shall be factory assembled and tested. Units shall have a minimum of 13.0 SEER.
- B. Casing shall be fully weather proof for outdoor installation and shall be galvanized steel, phosphatized and finished with baked enamel. Protective grille shall be provided around coil to protect fins from damage.
- C. Capacities shall be as scheduled with air entering the condenser and a saturated suction temperature at the compressor as indicated.
- D. Condenser coil shall be of nonferrous construction, with aluminum plate fins, mechanically bonded to seamless copper tubes and shall be circuited for subcooling. Units shall be furnished with direct-driven, propeller type fans arranged for vertical discharge. Fan motors shall be inherently protected and shall be permanently lubricated type.
- E. Compressors shall be of the welded hermetic design with internal spring isolators and shall have an automatically reversible oil pump. Compressors shall be located in a separate section from the condenser fans and coil. Guarantee shall be for a period of five years including parts and labor.
- F. All unit controls shall be factory wired. Safety devices shall consist of high and low pressurestat and compressor overload devices. Unit wiring shall incorporate a positive acting timer to prevent cycling of the compressor more than once in five minutes. Units shall have a discharge line thermostat, oil pressure switch, pressure relief valve and circuit breaker.
- G. Additional accessories - Provide low ambient control, time-delay relay, anti-short cycle timer, spring vibration isolation roof curb or rails suitable for isolating 90% of source vibration, and system shutdown upon lost or reversal of electrical phase(s).

H. Units to be manufactured by Trane, Carrier, Rheem, Rudd, or York.

PART 3 - EXECUTION

3.01 MATERIALS.

A. See appropriate sections for piping, fittings, valves, insulation, etc.

3.02 INSTALLATION

- A. Units shall be installed and started in accordance with the manufacturer's written instructions under the supervision of a factory representative from the manufacturer.
- B. Refrigeration system will be purged with dry nitrogen, and then evacuated with a vacuum pump for a period of 24 hours before charging system. Care will be taken to check for leaks before charging, and when charging system to not allow air to enter the system.
- C. Units will be installed on rails, sized by isolator manufacturer.

END OF SECTION

SECTION 15699

REFRIGERANT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15760 - Condensing Units.

1.02 SUBMITTALS

- A. Shop drawings shall be required on each size and type of field supplied valve, liquid indicator, filter dryer and major accessory to be installed on the Project.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. See appropriate Sections for piping, fittings, valves, insulation, equipment, etc.

2.02 SPECIALTIES

- A. Refrigerant valves shall be back seated, suitable for use with R-22 or as otherwise provide, sweat ends, Henry, Sporlan or Alco.
- B. Expansion valves shall be modulating, external equalizer type.
- C. Liquid Indicators: Shall be combination liquid moisture indicating type, double port with caps and shall be positioned so they may be easily read.
- D. Filter dryers shall be angle type employing replaceable molded porous cores accessible through bolted cartridge heads. Shells shall be heavy steel listed by Underwriters Laboratories with all internal parts cadmium plated steel. Units to be Sporlan series "C" Catch-all, or approved equal.
- E. All refrigeration specialties shall be suitable for the use and pressures involved in the systems, shall be the standard catalog products of a single manufacturer and shall be installed as recommended by the manufacturer to be compatible with the refrigerant type and system functions.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Filter driers shall be installed with shutoff valves up and down stream of the drier body with pressure relief valves where required by the system or recommended by the manufacturer. Cores must be replaceable without requiring the system to be totally pumped down.
- B. All field assembled refrigerant systems shall be equipped with a refrigerant relief valve where shown. Valve discharge shall be piped to a suitable point outside the building.

END OF SECTION

SECTION 15750

COILS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each size and type of coil to be installed on the Project.

1.02 RELATED WORK

- A. Section 15060 - Pipe and Pipe Fittings
- B. Section 15840 - Ductwork

PART 2 - PRODUCTS

2.01 DIRECT EXPANSION COOLING COIL

- A. Provide a direct expansion cooling coil where shown on the drawings. The coil shall be the size and capacity as indicated on the drawings.
- B. Coil shall be seamless copper tubes with mechanically bonded aluminum fins and shall be suitable for use with R-22. Refrigerant shall be distributed throughout the coil by a venturi type distributor.
- C. Coil shall have sweat end connections and shall be tested at 300 psig air pressure under water, shall be dehydrated and sealed before shipment and shall be suitable for 250 psig working pressure.
- D. Coils shall generally be provided by unit manufacturer as part of finished air handling unit assembly, and shall be mounted in a mastic lined drain pan with threaded drain connections

PART 3 - EXECUTION

3.01 COIL INSTALLATION

- A. Coil shall be installed where shown, adequately supported and braced, and with proper pitch to provide rapid draining.
- B. Selected coil sizes shall be coordinated with the sheet metal fabricating to facilitate mounting. Duct transitions, blankoffs, etc. may not be shown on the drawings, but must be provided to properly match the coil with the selected equipment

END OF SECTION

SECTION 15761

FAN COIL UNITS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each size and type of fan coil to be installed on the Project.

PART 2 - PRODUCTS

2.01 VERTICAL FAN COIL UNITS

- A. Fan coil units shall have the capacity as scheduled on the plans and shall be capable of heating only, cooling only, or combination heating and cooling as scheduled. Unit will be sized to meet scheduled capacity at no higher than medium speed or at a N.C. value not-to-exceed 35 at the unit. +
- B. Unit shall employ a direct-driven or multiple forward curved double inlet fan units on extended solid or hollow steel shafts with end bearings. Motors shall be high efficiency three speed permanent split capacitor type with oil tubes and reservoirs, automatic reset built-in motor overload protection like General Electric Type "KCP". Speed control and disconnect switch shall be factory mounted and wired to motor.
- C. Units shall be vertical blow-thru design filtered return. Access panel shall be locking type.
- D. Cabinets shall be 18 gage steel, shall be factory primed and painted in a baked enamel finish. Exposed units will have color to be as selected by Architect, and insulated with 1/2" of 1-1/2 # density fiberglass insulation. Provide insulated condensate pans under the cooling coils and removable extension under header and valve compartment.
- E. DX coils are to be aluminum fins on copper tubing suitable for working pressures of 250 psig and shall conform to the capacities shown on Fan Coil Schedule.
- F. Filters shall be throwaway fiberglass type.
- G. Fan Coils shall be size, capacity and configuration as indicated on drawings.
- H. Unit noise level shall be NC 35 or less at design conditions.
- I. Units to be as manufactured by Williams, Trane, CP Aon, Carrier, McQuay or approved equal.

PART 3 - EXECUTION

3.01 FAN COIL UNITS

- A. Units shall be installed where shown on the plans and shall be connected with shut off valves, unions, control valves and air vents as appropriate.
- B. Provide one set of filters at time of owners acceptance and one set for future Owner's use.
- C. Units shall have auxiliary drip pan with drain connected to a shut off type float in case of overflow.

- D. Cooling condensate drains shall be provided with p-trap air seals for all units with evaporator cooling coils. Auxiliary drain pans shall be provided under unit installed to prevent building damage in the event of a clogged condensate drain line.

END OF SECTION

SECTION 15764

ROOFTOP HEATING/COOLING UNIT

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15042 -- Systems Testing and Balancing
- B. Section 15840 -- Ductwork
- C. Section 15950 -- Sequence of Operation

1.02 SUBMITTALS

- A. Shop drawings shall be required on the complete air handling units indicating capacity, voltage, weights and dimensional data, and how they are to be installed on the Project. Drawings shall note in detail all requirements of these units and shall not be general in nature and will include roof curb information.

1.03 PRODUCT HANDLING

- A. Air handling units shall be stored, prior to installation, inside at all times.

PART 2 - PRODUCTS

2.01 ROOFTOP AIR HANDLING UNIT - 15 TONS AND LESS

- A. Furnish and install an AGA and ARI certified single-package downshot type, air-to-air cooling single zone-constant volume or variable air volume unit, complete with same manufacturer supplied acoustical roof curb where shown on plans. **System unit EER shall be 9.6 or greater.** Unit to be AAON or equal comparable complete constant volume units or variable volume controlled units provided by Carrier, Trane, Mammoth, or approved equal.
- B. General: All units shall be completely factory assembled, piped, internally wired with single point power connection with disconnect and fusing, and fully charged with R-22 and completely tested prior to shipment. Units serving as variable air volume units shall be suitable for Variable Air Volume application. All units shall be designed to operate at outdoor ambient temperatures as high as 120 F. Cooling and heating capacities shall be rated in accordance with A.R.I. standards. All cooling units shall be UL listed and C.S.A. certified. All units shall be designed for outdoor rooftop or ground level installation. Exterior surfaces of all units shall be phosphatized, zinc-coated steel with epoxy paint. Unit shall have direct expansion cooling, with compressor(s) and hot gas bypass or other suitable means of coil frosting control to modulate coil capacity.
- C. Motors: Shall operate at no more than 1750 rpm and be premium high efficiency rated.
- D. Casings: All panels shall be 20-gauge steel, gasketed and insulated. One-inch, one-pound density glass fiber mat-faced insulation shall be in the evaporator section. Unit cabinetry shall incorporate a standing top seam and channeled surfaces at all joining sections. Top panels shall be cross broken for water drainage. Unit cabinet shall be designed to operate at external static pressures up to 5.5 inches. W.G. Access doors shall be supplied on every section with steel hinges and latches and service retainer. Access doors

requiring screw and or bolt fasteners are not acceptable.

E. Refrigeration System:

1. Refrigeration Controls - refrigeration controls shall include condenser fan, evaporator fan and compressor contactors, and 24-volt transformer. Each circuit shall have a separate set of refrigerant controls. Safety controls shall include high and low pressure controls and compressor overloads.
2. Compressors - All units shall have 3,600 rpm hermetically sealed compressors. Compressors shall be equipped with over-temperature, over-current and high pressure controls. Crankcase heaters shall be standard on all models and a lockout circuit that prevents compressor restart until reset at the thermostat. All circuits are to have liquid line sight glasses. Unit shall be equipped with 5 minute anti-short cycle delay timer for each compressor. Compressor(s) to be covered with a 5 year parts warranty.
3. Evaporator Coil - Coils shall have 3/8-inch, OD seamless copper tubing mechanically bonded to aluminum fins. Each coil shall be factory pressure and leak tested at 225 psig.
4. Drain Pan - Evaporator pan shall be internally sealed and insulated with copper drain connections provided for evaporator section.
5. Condenser Coil - Outdoor coils shall have 3/8-inch, OD seamless copper tubing mechanically bonded to aluminum fins. Each coil shall be factory pressure and leak tested at 425 psig.
6. Indoor Air Fans - Belt-driven forward curved, centrifugal-type fans equipped with adjustable motor shaves shall be standard. The motor shall be thermally overload protected with permanently lubricated fan and motor bearings.
7. Condenser Fans - Shall have direct-drive, statically and dynamically balanced propeller fans, designed for low tip speed and vertical air discharge. Fan blades shall be constructed of steel and riveted to an Iridite dipped steel center hub. Weatherproof fan motors shall be UL listed or C.S.A. certified for outdoor use. They shall be heavy-duty, inherently protected, three-phase non-reversing type with permanently lubricated ball bearings and integral rain shield. All motors shall have built-in thermal overload protection.
8. Filters - Two inch throwaway filters shall be provided for initial startup, with 2" - 30% pleated provided upon turning project over to Owner. Unit shall have a clogged filter switch/alarm factory installed.

F. Accessories

1. Roof Mounting Curb - The roof curb shall be an insulated design with a acoustically lined solid bottom, to mate with unit and shall provide support and complete weathertight installation when properly installed. The curb shall be constructed of 16-gauge, zinc-clad steel. Curb shall ship assembled with factory-installed wood nailer strips. The roof curb design shall allow field-fabricated ductwork or accessory concentric supply/return ductwork to be connected directly to the curb.
2. Heater section-gas - Heat exchanger shall be suitable for use with natural gas burners. The heat exchanger shall have a welded aluminized steel combustion chamber. Secondary heat exchanger surface shall be of corrosion resistant aluminized steel tubing. A carbon steel heat exchanger surface shall not be acceptable. The heat exchanger design shall permit each section to freely expand and contract at its own rate, including each individual secondary tube.
3. There shall be no baffles within the heat exchanger design. There shall be no gasketed plates,

bulkheads, or ports between the inside of the heat exchanger and the supply air stream. Cleanout of the heat exchanger shall be accomplished without removing casing panels or passing soot through the supply air passages. The heat exchanger shall have a condensate drain. The burner shall have a forced draft type (not requiring induced draft fans, draft hoods, barometric dampers, or chimney draft). The burner, controls and valves shall be housed within the integral burner vestibule. The vestibule door shall be hinged and equipped with steel retainer rod to hold the door open for service. The burner shall be fire tested and adjusted at the factory. Final adjustments shall be made in the field at initial start-up by a qualified service organization.

4. 2 and 4 stage gas burner shall be capable of efficient operation from 25% (4 stage) and 50% (2 stage), through 100% of rated capacity. Gas burners shall be forced draft type, complete with flame supervision, integral prepurge timing, combustion air proving switch, intermittent pilot with spark ignition, and a complete gas train. The gas train shall include the main gas valve, main pressure regulator, main shut-off cock, pilot gas valve, pilot pressure regulator, and pilot cock.
5. Time Delay Relay - Shall provide a 20 second time delay between starting of the first and second compressor, on multiple circuit units.
6. Anti-short cycle Timer - A lockout time that shall provide a minimum off time of five minutes between compressor cycling.

G. Outside Air Options

1. Downflow Economizer/Factory Installed - Modulating enthalpy-controlled economizer shall be operated through the room thermostat to automatically use outdoor air for free cooling when outdoor air temperature and humidity are at acceptable level. Automatically modulating outdoor and return air dampers shall maintain proper discharge air temperature into the conditioned space. Adjustable minimum position control shall be standard. Economizer shall have spring return motor. Upon loss of power, dampers shall close shut. Economizers shall have the energy saving "ultra" low-leak economizer dampers. These dampers shall reduce damper leakage down to 10 cfm/sq.ft., one-inch wg differential static pressure. That shall be less than one percent of nominal unit airflow according to tests completed at The Air Movement and Control Association (A.M.C.A.) Laboratories in accordance with A.M.C.A. Standard 575. Barometric relief shall be included.

- H. All units shall have decals and tags to indicate unit capacity, caution areas, filter scheduling, and unit service. Unit nameplates shall be fixed to the deadfront cover in the main control panel. Electrical wiring diagrams shall be attached to control panels. Installation and maintenance bulletins shall be supplied with each unit.
- I. The frame and unit base shall be minimum 14-gauge galvanized steel sizes. The unit base shall overhang the roof curb for water run-off and shall have a formed recess that seats on roof curb gasket to provide a positive weathertight seal. Exterior panels shall be constructed of 18-gauge galvanized steel. Access doors for the supply air fan, and filter sections shall include 20-gauge galvanized steel door liners. All side access doors shall seal to vinyl, dual durometer gasketing which use air pressure differential to guarantee sealing.
- J. Coil sections shall be arranged for removal of coils from either side of the unit. Cooling Coil section shall have drain pans which are fully insulated and have a galvanized steel liner. Provide troughs and downspouts where cooling coils are stacked. Condensate drain shall have P-trap at discharge, furnished by unit manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install single-package unit on Manufacturer supplied acoustical roof curb. Installation shall comply with manufacturer's instructions for clearances, arrangement, etc. Unit to set level on roof.
- B. Patch all leaks found during pressure testing on the air handling unit, flexible connections, and connecting ductwork. Install to provide service access to unit as recommended by manufacturer.
- C. Set unit to provide 25% outside air, or as indicated on drawings.
- D. Units shall have P-traps installed on all condensate drains at the unit.

END OF SECTION

SECTION 15820

EXHAUST AND VENTILATION FANS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each size and type of fan and curb to be installed on the Project.

1.02 Related Work

- A. Section 15161 - Vibration Isolation.
- B. Section 15840 - Ductwork.
- C. Section 15860 - Backdraft Dampers
- D. Section 15950 - Sequence of Operation.

PART 2 - PRODUCTS

2.01 CABINET FANS

- a. Provide, where shown on the Drawings, direct or belt drive centrifugal cabinet exhaust fan, of the size and capacity shown on the schedule. Fan wheel shall be true centrifugal in operation, and shall bear the AMCA Certified Ratings Seal and be listed under the UL Standards 507 and 705. Entire fan, motor and wheel shall be removable without disturbing the housing. Motor speeds shall not exceed 1100 RPM. Fan motors shall be suitably grounded and mounted on rubber-in-shear isolators. When Solid state speed controller is used, the fan and controller should be UL listed as a combination assembly. Fan assembly shall also have disconnect, and backdraft damper. Fan to be Penn Zephyr/Zephyrette, or approved equal by JennFan, Greenheck, Flakt, Barry Blower, or Loren Cook.

PART 3 - EXECUTION

3.01 CEILING MOUNTED FANS

- A. Fans shall be suspended from suitable structure by manufacturer-provided isolators. Fans less than 50 lbs shall be hung using rubber in shear isolation; fans weighting more than 50 lbs shall be suspended by spring isolators, in accordance with Section 15161 - VIBRATION ISOLATION.

3.02 START-UP

- A. All fans shall be installed, aligned, lubricated, started and balanced, all in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 15832

ROOF AND WALL VENTS

PART 1 - GENERALS

1.01 SUBMITTALS

- A. Shop drawings shall be required for each size and type of weather cap to be installed on the project.

1.02 RELATED WORK

- A. Section 15840 - Ductwork
- B. Section 15820 - Fans

PART 2 - PRODUCTS

2.01 EXHAUST AIR

- A. Provide prefabricated aluminum weather cap for inline or cabinet exhaust fans.
 - 1. For exhaust fan discharge through roof, provide a roof jack/cap.
 - 2. For exhaust fan discharge through wall, provide a wall cap.
- B. Unit to provide weather proof protection, with backdraft damper to prevent wind and rain from entering building.
- C. Vents shall be black in color and shall be sized for minimal pressure drop.
- D. Manufacturer to be by Metalbestos or exhaust fan manufacturer.

PART 3 - EXECUTION

- A. Weather cap shall have a bottom flange which shall mate with roof system to provide a leak-proof assembly.
- B. Penthouse shall have a bottom flange which shall mate with a prefabricated roof curb. All penthouses shall be set on curbs. Verify slope of roof.
 - 1. Curbs shall be installed only on the structural deck, not on the insulation or roofing. All curbs shall be leveled when installed.

END OF SECTION

SECTION 15840

DUCTWORK

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15010 - General Provisions
 - 1. Seismic Restraints
- B. Section 15042 - Testing and Balancing.
- C. Section 15849 - Duct Hangers and Supports.
- D. Section 15860 - Duct Accessories.

1.02 SUBMITTALS

- A. Shop drawings shall be required on the flexible ductwork, flexible connection material, factory fabricated devices to be installed on the Project.

PART 2 - PRODUCTS

2.01 SHEET METAL

- A. Shall be lock-forming, quality steel and shall have a galvanized coating of 1-1/4 ounces total for both sides of one square foot of a sheet.
- B. Gauges shall be as recommended for the use intended in the applicable SMACNA Manuals.
- C. All ductwork and other sheet metal shall be properly stiffened and supported as per the applicable recommendations of SMACNA Manuals. Only first quality, smooth, cold rolled sheets of the best grade steel shall be used and shall be guaranteed to double seam without showing fracture. All turns and elbows shall be equipped with turning vanes.
- D. All radius elbows or turns shall be of approximate radius shown on the drawings, and in no case shall the radius in the throat be less than 1/3 of the diameter or width of the pipe of which it is a part. Radiused turns shall be used on elbows 12" and under at Contractors option if not shown on drawings with Engineers permission.
- E. All longitudinal joints in low pressure ductwork shall be lock seamed by Pittsburg Lock Former, or approved equal. All girth joints on ducts shall be secured by "S" clips and drive cleats. All girth joints on ducts larger than 15" shall be cross broke or stiffened to prevent bulging, vibration or sagging.

2.02 ROUND OR FLAT OVAL DUCTS

- A. Provide round and flat oval ducts where shown on the drawings with metal gauges in accordance with the following schedule:

<u>Pipe Diameter</u>	<u>Gage</u>	<u>Fitting Gage</u>
Up to 14"	26	22 (Up to 8")
15" to 26"	24	20 (9" to 14")
27" to 36"	22	20
37" to 50"	20	20
51" to 60"	18	18

- B. Ductwork shall be of the spiral design with an airtight seam construction and shall employ insertion and sleeve type couplings which shall be calked and metal screwed or welded together to form a smooth inner surfaced duct system which will withstand 2.0" W.G. pressure. Round ductwork shall be constructed of galvanized steel meeting ASTM A-525-64T.
- C. Ductwork shall be prefabricated as manufactured by Semco, Spira Matic, United Sheet Metal, United McGill, C & R.
- D. All takeoffs, tees, and 90's will be done with mitered fittings. Taps to main ductwork will be done with two 45° connections; 90's will be done with no less than 5 piece mitering.

2.03 FLEXIBLE CONNECTIONS

- A. All flexible connections in ductwork shall be constructed of a plastic-coated fabric which is fireproof, which will not permit leakage of air and which is not affected by temperatures as low as -10°F, or as high as 200°F.
- B. Connection material shall be as manufactured by Ventfabrics "Ventglass", or approved equal by Novatex or Amatex.

2.04 SEALER

- A. Thoroughly seal all air ducts, taps, etc., against air leakage and all exterior return air ducts against moisture leakage. Paint or trowel the sealer on the joints before assembly. Sealer shall be 3-M, Bauer and Black or Childers.

2.05 FLEXIBLE DUCTWORK

- A. Flexible ductwork is limited to a maximum length of 4 feet, with no dips, sags, or tight elbows.
- B. Flexible ductwork shall be an insulated, semi-rigid and lightweight air duct, manufactured by using a dead soft aluminum strip which is spirally wound and mechanically joined together forming an air tight - leakproof triple lock seam. Duct to be a self-supporting and corrosive resistant UL-181 Class I product, with a polyethylene vapor barrier.
- C. Flexible ductwork to be like Flexmaster Type TL-ALV (Acoustical) or an approved equal.

PART 3 - EXECUTION

3.01 SHEET METAL INSTALLATION

- A. All ductwork shall generally be installed in the location and manner shown and detailed on the drawings with all fittings and connections made in accordance with the applicable SMACNA Manuals. All modifications or deviations required by job conditions must be approved by the Architect's representative prior to any fabrication.
- B. All connections from sheet metal assemblies such as ductwork, plenums, etc., to operating machines and/or mechanisms such as fans, air-conditioners, etc., shall be flexible connections.
- C. Where any horizontal sheet metal ductwork is mounted lower than 7'-0" above a finished floor line of interstitial space, all corners of standing seams in ducts shall be hammered flat and covered with Duct Tape.
- D. When ductwork passes through all walls, roofs, ceilings or floors, they are to be surrounded by sleeves and sealed against water, air and smoke penetration.
- E. All non-radius elbows or tees shall be provided with air extractor type turning vanes.
- F. Elbows and tees, less than 12" wide, shall be radius type, unless available space does not permit. Larger size elbows and tees shall be provided with turning vanes and/or splitter dampers to aide air flow and balancing.
- G. The flexible connections shall be held in place by 1" by 1/8" band iron bolted in place around the entire perimeter of the connecting ductwork. No flexible connection shall be less than 4" long (net) between connected sections of ductwork.
- H. Sheet Metal Contractor shall submit two (2) copies of duct fabrication drawings to the Test and Balance Contractor for review. The TAB Contractor shall return one (1) copy marked with an additional balancing dampers, etc. required to properly balance the system. Any additions shall be installed by the Sheet Metal Contractor at no additional cost to the Owner.
- I. Contractor shall protect the interior of all ductwork sections that are stored on site or have been installed from weather, dirt, debris, etc.
- J. Ductwork will be thoroughly cleaned and cleared of debris, dirt, etc., before system is put into operation.

3.02 FLEXIBLE DUCTWORK

- A. Flexible ductwork can only be used and installed at connections to diffusers with no dips, sags, or tight radius 90's. Flex duct shall be installed to per manufacturer's recommendation.

END OF SECTION

SECTION 15849

DUCT HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 15010 - General Provisions

1. Seismic Restraints.

B. Section 15840 - Ductwork.

PART 2 - DUCT HANGERS

2.01 DUCT HANGERS

A. All horizontal ducts and connections shall be securely hung in position by galvanized steel bands not lighter than #12 gage, or carried on suitable cradles as best suited to the location and fire resistance capability for U.S. fire rated ceilings. All hangers for ducts shall be securely fastened to the basic building structure.

2.02 SLEEVE

A. Sleeves for duct shall be made of galvanized roll sheet steel no lighter than 18 gage.

2.03 SILICONE FOAM SEALANT

A. Ducts passing through existing and new roof system shall be sealed with Dow Corning 3-6548 silicone RTV foam or General Electric RTU silicone foam compound RTV 850.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Duct hangers and support will normally not be shown on the drawings, however, must be installed at the proper intervals according to the appropriate SMACNA Manuals by this trade.

B. Sealing shall be done with silicone foam sealant.

END OF SECTION

SECTION 15860

DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED WORK

- A. 15047 - Testing and Balancing
- B. 15161 - Vibration Isolation
- C. 15840 - Ductwork

1.02 REFERENCE STANDARDS

- A. Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems.
- B. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.03 SUBMITTALS

- A. Shop drawings shall be required for each factory fabricated duct device and accessory to be installed on the Project.

PART 2 - PRODUCTS

2.01 TURNING VANES

- A. Turning vanes shall be single thickness construction, with turned back edges, constructed and installed per SMACNA recommended standards.

2.02 FABRIC BACKDRAFT DAMPERS

- A. Frame shall be .050" 6063-T5 extruded aluminum alloy. For velocities under 300 fpm, blade material shall be #1010 Cohrlastic; 300 fpm and higher shall be neoprene coated fiberglass. Damper to be AMCA certified.
- B. Stop shall be .041" x 1/2" vinyl coated galvanized steel mesh. Finish shall be mill finish.
- C. Backdraft dampers shall be American Warming BD14/15 or equal by Louvers and Dampers, Air Balance, Ruskin, NCA, Vent Products, or Airline.

2.03 AIR EXTRACTOR

- A. Adjustable air scoop style, with turning vanes on and adjustable frame, capable of keeping turning vanes properly aligned in air stream for air balance and as an aide to air flow.
- B. Manufacturer to be Anemostat, Titus, Carnes, NCA, Vent Products, or approved equal.

2.04 VOLUME DAMPERS, SPLITTERS, AND ADJUSTABLE DEFLECTORS

- A. Volume dampers shall be fabricated of galvanized steel, minimum 16 gauge and shall be controlled from outside of the ducts; held in place by graduated quadrants which can be locked in any position. Where ducts are concealed, quadrants shall be installed with extended control rod to the ceiling as necessary to permit adjustment at any time. Access to all adjusting mechanisms must be available. Adjusting quadrants shall be as manufactured by Ventfabrics, or an approved equal.
- B. Splitter dampers shall be fabricated of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration, made of a minimum 18 gauge galvanized steel. Size on basis on straight air volume proportioning. Splitters shall be easily and fully adjustable, and capable of being locked in position after adjustment. Splitters shall be made readily accessible for adjustment.
- C. Adjustable deflectors and adjustable turning vane devices for diverting air flow from a duct main into a branch duct, shall be multi-blade assembly hinged at one end and so constructed that, as it is closed, the air passage between the blades narrows until no air passage remains when the assembly is in the fully-closed position. These deflectors shall be Titus #AG45 or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all items in accordance with manufacturer's printed instructions.

3.02 TURNING VANES

- A. Shall be provide at all non-radiused elbows, or tees.

3.02 FABRIC BACKDRAFT DAMPERS

- A. Backdraft dampers shall be provide at all exhaust fan discharges, where backdraft damper is not provided by fan manufacturer.

3.03 AIR EXTRACTOR

- A. Air Extractor type turning vanes are to be installed at branch duct connections to main duct, and may substitute for a manual balancing damper.

3.04 VOLUME DAMPERS

- A. Volume dampers shall be installed in all of the trunk and branch ducts (supply, return, outside air, and exhaust) as shown or required. The balancing trade shall NOT depend upon register shutters or dampers for balancing and these must be left wide open while the system is being balanced.

END OF SECTION

SECTION 15870

OUTLETS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be required on each style or type of grille, register, diffuser and frame to be installed on the Project.

PART 2 - PRODUCTS

2.01 Acceptable Manufacturers:

- A. Anemostat.
- B. Carnes.
- C. Titus.
- D. Metalaire..
- E. Price.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All grilles, registers and diffusers for the entire Project shall be installed in the prescribed manner of the manufacturer with special attention to the type of construction in which the particular device will be set. Take special care in locating and sizing openings through finished surfaces to insure complete coverage of rough openings by integral device flanges or auxiliary frames.
- B. Diffuser supplier shall guarantee that outlet velocities shall not exceed 1200 FPM and that NC levels shall not exceed 30.
- C. Coordination of like inlet and outlet devices in various types of ceiling or wall construction will be the responsibility of this trade and must be verified from the drawings. All Grilles and registers to be furnished with plaster frames unless installed in acoustical ceiling tile. Where ductwork is visible through face of grille, sheet metal shall be painted flat black.

END OF SECTION

SECTION 15880

AIR FILTERS AND TREATMENT UNITS

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. All materials and equipment shall be new and shall conform to the applicable standards of the following agencies:
 - 1. American Society of Heating Ventilating, Refrigerating And Air Conditioning Engineers, ASHRAE.
 - 2. National Bureau of Standards, NBS.
 - 3. National Fire Protective Association, NFPA.
 - 4. Underwriters' Laboratories, Inc., UL.

1.02 SUBMITTALS

- A. Shop drawings shall be required on each type and style of filtering media to be installed on the Project.

PART 2 - PRODUCTS

2.01 FILTERS, GENERAL USE

- A. Filters shall be 1" thick and a dry type, reinforced laminated cellulose spun glass pleated cartridge type, having a mean efficiency of 30% minimum on ASHRAE 52-76 type tests. Filters shall be Underwriters Class 2 rated.
- B. Mounting frame shall be of the same manufacturer as the cartridge and shall be a universal holding frame with spiral latch.
- C. Filters for the HVAC Units shall be Farr 30-30, mounted in filter tracks provided as an integral part of these units. Equal as manufactured by American Air Filter, Cambridge, Flanders or Continental.

PART 3 - EXECUTION

3.01 FILTERS

- A. All units requiring filters shall have one set of filters for use during construction, one complete new set of media installed at time of Owner's acceptance.
- B. Special care must be taken to match the filtering holding frames, plenums or boxes to the physical sizes of the adjacent equipment.

END OF SECTION

SECTION 15896

ELECTRIC HEATING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 15950 - Sequence of Operation.
- B. Division 16 - Electrical.

1.02 REFERENCE STANDARDS

- A. All materials and equipment shall be new and shall conform to the appropriate standards of the following agencies:
 - 1. National Electrical Manufacturer's Association, NEMA.
 - 2. National Electrical Code, NEC.
 - 3. Underwriters' Laboratories, Inc., UL.

1.03 SUBMITALS

- A. Shop drawings shall be required on each size and style of electrical heating device.

PART 2 - PRODUCTS

2.01 CABINET HEATERS

- A. Provide electric cabinet heaters, as specified on the drawing schedule, of the fan forced down flow design suitable for fully recessed mounting or surface mounting in a box with a 16 guage steel face cover plate. Access to heater controls shall be through a locking access door in the face plate.
- B. Heating element shall be nickel chromium resistance wire sheathed in a metal jacket. Fins shall be aluminum. The fan motor shall be a totally enclosed self-lubricating and non-interfering type.
- C. Unit accessories shall consist of a disconnect switch, thermostat, thermal limit switch and fan delay switch.
- D. Heater shall be Raywall or approved equal by Qmark, Chromolox or Trane.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All electric heating equipment shall be installed where shown and shall have the operating and safety controls as specified, all mounted and ready for wiring.
- B. Where access to electric heating elements will be through access doors or panels, they shall include a dead front type switching arrangement to disconnect the heater elements.

END OF SECTION

SECTION 15937

CONTROL DAMPERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Automatic dampers for the control and proportioning of air into and out of all air handling systems shall normally be provided under this Section of the Specifications unless specifically superseded in the air moving device equipment sections.
- B. All dampers shall be of similar construction to those specified herein regardless of its source of manufacturer.

1.02 RELATED WORK

- A. Section 15810 - Furnaces.
- B. Section 15860 - Duct Accessories

1.03 SUBMITTALS

- A. Shop drawings shall be required for all items supplied.

PART 2 - PRODUCTS

2.01 AUTOMATIC DAMPERS

- A. Modulating and or motorized dampers, unless otherwise specified elsewhere, shall have damper frames using 13 gauge galvanized steel channel or 1/8" extruded aluminum with reinforced corner bracing. Damper blades shall not exceed 10 inches in width or 48 inches in length. Blades are to be suitable for high velocity performance. Damper bearings shall be as recommended by manufacturer for application. Bushings that turn in the bearing are to be oil impregnated sintered metal. All blade edges and top and bottom of the frame shall be provided with replaceable, butyle rubber or neoprene seals. Side seals may be spring-loaded stainless steel. The seals shall provide a maximum of 1% leakage at a wide open face velocity of 1500 FPM and 4" W.C. close-off pressure. The damper linkage shall provide a linear flow or equal percentage characteristic as required.
- B. Control dampers shall be parallel or opposed blade type as scheduled on drawings or outdoor and return air mixing box dampers shall be parallel blade, arranged to direct airstreams towards each other. All other dampers shall be or opposed blade type.

2.02 DAMPER ACTUATORS

11/08

- A. Actuators shall be of the push-pull or rotary type for modulating, 3-point floating, or 2-position control as required by the application. The actuator shall use an overload-proof synchronous motor or an electric motor with end switches to de-energize the motor at the end of the stroke limits. Control voltage shall be 24VAC, 0-20VDC, or 4-20ma as required. Actuators shall be available with spring return to the normal position when required. Actuators shall have a position indicator for external indication of damper position. Actuators shall have manual override capability without disconnecting damper linkage.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Automatic dampers which are furnished by the temperature control trade shall be set in place by the sheet metal trade under the supervision of the temperature control trade. All blank off plates and conversions necessary to install other than duct sizes dampers are the responsibility of the sheet metal trade.
- B. Mounting, connecting, sequencing and complete operation of damper operators shall be the responsibility of this Contractor.

END OF SECTION

SECTION 15950

SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 PROJECT SCOPE

- A. It is the intent of this project to, but not limited to, provide space temperature control for the this project, to include control of fan coils, air handlers, exhaust fans, and other items indicated on the drawings.
- B. The sequences described herein shall be strictly adhered to as to the scope of the operation. All required devices to accomplish these sequences shall be furnished whether specified or not. All devices not furnished by equipment manufacturers shall be supplied by this Contractor.

1.02 RELATED WORK

- A. Section 15660 - Condensing Units
- B. Section 15761 - Fan Coils
- C.C. Section 15764 - Air Handlers
- D. Section 15820 - Supply and Exhaust Fans
- E. Section 15896 - Electric Heating Equipment

1.03 SHOP DRAWINGS

- A. Shop drawings shall be a provided for the control of all equipment as specified herein.

1.04 OWNER OPERATION AND MAINTENANCE INSTRUCTION

- A. Provide a minimum of four hours of personnel instruction for the owners maintenance staff.
- B. Provide two extra sets (copies) of written maintenance and operation instructions for all system components, in addition to O&M Manuals as stated in Specifications. Copies shall include system wiring diagrams as well as specific temperature settings, etc..

1.05 SYSTEMS CONTROLLED

A. The control specification is intended to cover the automatic control of heating, ventilating, and air conditioning of the following, but not limited to:

- Condensing Units
- Fan Coils
- Rooftop Units
- Cabinet Heaters
- Exhaust Fans
- Smoke Exhaust Fans
- Stairwell Pressurization Fans

1.06 SHOP DRAWINGS

A. Shop drawings shall be provided for the control of all equipment as specified herein.

B. The controls contractor shall submit schematic drawings for the entire control system for review and approval before work shall begin. Included in the Submittal drawings shall be a one page diagram depicting the system. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

C. The submittals shall include manufacturer's catalog data describing each item of control equipment or component provided and installed for the project.

1.07 APPROVED MANUFACTURERS

A. The control system shall be furnished, engineered, and installed by the manufacturer's local factory owned branch office or the manufacturer's locally authorized representative. The control contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 48 hours upon receipt of request.

B. Control system components shall be new and in conformance with the following applicable standards for products specified:

1. American Society for Testing and Materials, ASTM
2. Institute of Electrical and Electronic Engineers, IEEE
3. National Electrical Manufacturers Association, NEMA
4. Underwriters Laboratory, UL (UL 916)
5. FCC Regulation, Part 15, Section 156
6. National Fire Protection Association, NFPA

7. Local Building Codes

PART 2 - PRODUCT

2.01 GENERAL

- A. Mechanical Contractor will furnish and install a complete and fully functioning Electronic based temperature control system
- B. All temperature control wiring shall be labeled and correspond to wiring diagrams.
- C. Temperature Control Manufacturer to be Carrier, Honeywell, Johnson Controls, Staefa, or approved equal.

PART 3 - EXECUTION

3.01 Rooftop Units

- A. Unit shall cycle from heating and cooling on its own controls.
- B. Each unit shall be controlled by the Zone Thermostat, a microcomputer thermostat with 7-day programmability, 1-stage heat and 1-stage cool, automatic switching from heat to cool, provided by air handling unit manufacturer. Thermostat to be like Johnson Controls T500 Series, TCS Basys Controls, Honeywell, or Enerstat. Thermostat will have a Fan-Off-Auto and Heat/Cool/Auto control switch and shall be the color white or off-white as selected by the Architect.
 - 1. During occupied settings, fan shall run continuous. During setback operation, fan shall run as required to satisfy setback temperatures.
 - 2. Outdoor air damper shall be a two position damper that will open upon fan operation, during occupied setting, and close when fan is off, and during unoccupied setting. Minimum outside air setting to be 10% of supply air or as scheduled on drawings.

3.02 EXHAUST FANS

- A. Fans will run continuous as controlled by light switch (provided by E.C), or as specified on drawings.

3.03 ELECTRIC CABINET HEATER

- A. Unit shall cycle on its own unit mounted controls. Set thermostat to 65° F. (adjustable).

3.04 Smoke Evacuation System

1. Upon activation of smoke / fire alarm the smoke evacuation fan serving atrium zone will run, and intake louvers shall open.
2. All stairwell pressurization fans SF #1 thru #2 shall run.
 - a. Fans shall be interlocked with respective relief louvers. Louvers shall open when fan operates and close when fan ceases operation.
 - b. Stairwell pressurization fan control shall be automatic from a signal by the Fire alarm panel and/or temperature control panel (that received fire alarm signal from the fire alarm panel) and shall be capable of manual operation on remote stairwell pressurization panel located in Mech. Room 102 for Firemen use.
 - c. Remote stairwell pressurization panel shall indicate current condition of pressurization system, off, on, automatic control, manual on (override), manual off (override).
3. The smoke evacuation mode shall be manually reset at temperature control panel. Indication lights, in conjunction with system graph of various system operations modes will be indicated on temperature control panel.

END OF SECTION

ELECTRICAL

SPECIFICATION INDEX

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SECTION 16010

GENERAL PROVISIONS

PART 1. GENERAL

SECTION 1.01 RELATED DOCUMENTS

- A Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.

SECTION 1.02 DESCRIPTION OF WORK

- A The Electrical General Provisions are in addition to the General Conditions, and General Requirements, and shall be an extension of these sections of the Specifications.
- B The Electrical General Provisions apply to all electrical materials, equipment, installations, and services supplied under any portion of the work.
- C The Electrical contractor shall coordinate the Electrical General Provisions as applicable to any equipment, installations, and services of an electrical nature.
- D It is the intention of this Division of the Specifications and the accompanying drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and successful operation of all equipment, materials, devices and necessary appurtenances to provide a complete electrical system, together with such other miscellaneous installations and equipment hereinafter specified and/or shown on the plans. The work shall include all materials, appliances and apparatus not specifically mentioned herein or noted on the plans, but which are necessary to make a complete working installation of all electrical systems shown on the plans or described herein. Equipment and devices furnished and installed under other Divisions of this specification shall be connected under this Division. The drawings and specifications are complementary and what is called for in either is binding as if called for in both.
- E The contract drawings indicate the extent and the general location and arrangement of equipment, conduit and wiring. The Electrical contractor shall study building plans and details and shall cooperate with all other trades to prevent conflict and interference as to space requirements so that outlets and equipment will be properly located and readily accessible. Lighting fixtures, equipment and outlets shall be located to avoid interference with mechanical or structural features. Lighting fixtures shall be symmetrically located according to the room arrangement. Raceways, junction boxes, outlet boxes and lighting fixtures shall be properly supported to comply with applicable codes and good work practice. Electrical contractor is responsible for installation of a complete and operating electrical installation in accordance with the true intent of the drawings and specifications.
- F The scale of drawings cannot show all necessary transitions, offsets, changes in direction, etc. It shall be the responsibility of the Electrical Contractor to provide all pull boxes, etc., necessary to install his work to conform to the structure, to preserve headroom and to keep openings and passageways clear.
- G Risers and other diagrams are schematic only, not to scale, and do not necessarily show physical arrangement of equipment. Riser diagrams and floor plans are complementary and what is shown on either is same as if shown on both.

- H The horsepower of motors and apparatus wattage indicated in the plans are estimated requirements of equipment furnished under other sections of the specifications. All wiring, circuit breakers, manual motor starters, and magnetic motor starters shall be of the sizes and capacities to suit the horsepower of the motors and equipment actually furnished under the various sections of the specifications. However, in no case shall wiring, circuit breakers, manual motor starters, and magnetic motor starters be of smaller capacities than those indicated on the drawings or specified unless required by code or authority having jurisdiction; and then only after Contractor notifies Engineer in writing of such.
- I Any minor changes in the location of the conduits, outlets, etc., from those shown on the plans shall be made without extra charge if so directed by the Architect/Engineer before rough-in.
- J Make detailed arrangements with utility companies for previously selected electrical and telephone services. Furnish and install:
 - 1 Facilities for utility service and pay charges required by utility companies to provide temporary and permanent services.
 - 2 All facilities required for utility company metering and meter protective devices.
 - 3 Coordinate work with Telephone company for a complete installation of telephone service.

SECTION 1.03 PERMITS AND FEES

- A This work shall include the procurement of and payment for all permits and fees for the performance of the electrical work.

SECTION 1.04 SUMMARY OF WORK

- A The following is a general description of the Work included in this contract, but this description is not all inclusive nor is the work limited to the following:
 - 1 Complete electrical distribution system: including new circuit breakers branch circuit wiring, motor control and circuit disconnect devices, and outlet devices.
 - 2 All electrical work for mechanical systems, except where specifically indicated to be furnished and installed as part of other sections of Specifications.
 - 3 Complete fire alarm system: including new pull stations, horns, strobes, wiring and other devices.
 - 4 Complete communications, intercom/access conduit systems.

SECTION 1.05 QUALITY ASSURANCE

- A In case of difference between building codes, specifications, state laws and federal laws, local ordinances, industry standards and utility company regulations and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Architect/Engineer in writing of any such difference.

SECTION 1.06 NON-COMPLIANCE

- A Should the Contractor perform any work that does not comply with the requirements of the applicable building codes, state and federal laws, local ordinances, industry standards and utility company regulations, he shall bear all costs in correcting all deficiencies.
- B Applicable codes and standards shall include all the state laws, local ordinances, utility company regulations and the applicable requirements of the following nationally accepted codes and standards. All of the following codes shall apply to the equipment, and equipment installation, of Division 16, where applicable. All equipment of Division 16 shall bear U.L. labels where labeled equipment is available.
- C Industry Standards, Codes and Specifications:
- 1 NEC National Electric Code (NFPA No. 70).
 - 2 UBC Uniform Building Code - International Conference of Building Officials.
 - 3 ANSI C2: National Electrical Safety Code.
 - 4 IEEE Institute of Electrical and Electronic Engineer.
 - 5 IPCEA Insulated Power Cable Engineers Association.
 - 6 NEMA National Electrical Manufacturers Association.
 - 7 NFPA National Fire Protections Association.
 - 8 UL Underwriters Laboratories.
 - 9 NECA Standard of Installation.
 - 10 FIPS Pub. 94 Guideline on Electrical Power for ADP Installations.
 - 11 NFPA No. 101 Life Safety Code.
- D All electrical materials shall be new, in original cartons, bundles, or shipping crates and shall have U.L. label whenever available.
- E Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes. Also, this shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of the herein before mentioned governing codes and rules and not contrary to same.

SECTION 1.07 INSTALLERS

- A A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project, unless specified otherwise in other specific sections of Division 16.

B The selected Electrical Contractor shall provide to the Electrical Consultant the following information.

1 Electrical Superintendent Information

- a Name
- b History with like projects
- c Qualifications

2 Electrical Project Forman

- a Name
- b History with like projects
- c Qualifications

3 Electrical personnel assigned to this project

- a Names
- b Qualifications

SECTION 1.08 EQUIPMENT FLOOR PLAN

- A After approval of material is secured, prepare a floor plan of such electrical equipment room drawn to a scale of $1/2" = 1' - 0"$ and submit for approval in the same manner prescribed for shop drawings. Equipment shown shall be an exact dimension of equipment to be used by Contractor.
- B Be responsible for equipment ordered and/or installed prior to receipt of shop drawings returned from the Architect bearing the Electrical Engineer's stamp of "Approved" or "Approved as Corrected". Corrections or modifications to equipment as noted on shop drawings shall be performed or equipment removed from the Job Site at request of Architect/Engineer without additional compensation.
- C Submit shop drawings and technical data for all electrical equipment unless otherwise indicated in the Specifications.
- D Submittals will be checked for general compliance with Specifications only. Contractor shall be responsible for deviations from the drawings or specifications and for errors or omissions of any sort in submittals.
- E O & M Manual submittals shall be submitted for all electrical equipment.

SECTION 1.09 RECORD DRAWINGS (AS BUILTS)

- A Corrections and changes made during the progress of the work shall be recorded continuously by the Division 16 contractor on a set of prints and one set of reproducible kept readily available at the project during construction. Accurately locate all underground and under slab raceways and stub-outs. At the completion of the work, Contractor shall furnish the Architect/Engineer a set of reproducible record drawings and original prints marked up for review. Final payment to the Electrical contractor will not be authorized until these have been submitted to and accepted by the Architect/Engineer.

SECTION 1.10 FINAL ACCEPTANCE REQUEST

- A The Electrical contractor shall submit to the Architect, with a copy to the Engineer, a Job Completion Form properly filled out at the time final acceptance of the electrical work is requested.

PART 2. PRODUCTS

SECTION 2.01 OPERATIONAL AND WARNING SIGNS

- A General: Provide warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location.
- B Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING."

PART 3. EXECUTION

SECTION 3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A Handle all equipment carefully to prevent internal components damage, breakage, and denting and scoring of the finish. Do not install damaged equipment.
- B Store equipment in a clean, dry space. Protect equipment from dirt, fumes, water, construction debris, and physical damage.
- C Provide auxiliary heater, or store in a heated space, for any equipment that would be damaged by moisture condensation, such as electric motors, electronic components, contacts, etc.

SECTION 3.02 SITE INSPECTION

- A Electrical contractor must examine the areas and conditions under which electrical equipment is to be installed and notify the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer and the Architect/Engineer.

SECTION 3.03 SAFETY MEASURES TO BE TAKEN

- A The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Architect and Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the construction site. It shall be the Contractor's responsibility to comply with "Safety and Health Regulations for Construction," Volume 36, No. 75, Part II of the Federal Register by the U.S. Department of Labor. Contractor shall be responsible for providing all such safety measures and shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether he is or is not in compliance with state or federal regulations.

SECTION 3.04 WORK RESPONSIBILITIES

- A Drawings indicate diagrammatically desired locations or arrangement of conduit runs and outlets equipment. Proper judgement shall be exercised in executing Work so as to secure best possible installation in available space and to overcome local difficulties due to space limitations or interference with structural conditions. Contractor shall be responsible for correct placing of Work and proper location and connection of Work in relation to Work of other trades. Advise appropriate trade as to locations of access panels.
- B Where others furnish equipment, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- C Scaled and figure dimensions are approximate of typical equipment of the class indicated. Before proceeding with any Work, check and verify dimensions and sizes with Drawings to see that equipment will fit into spaces provided without violation of applicable codes.
- D Should any changes to Work indicated on drawings or described in Specifications be necessary in order to comply with above requirements, notify Architect/Engineer immediately. Cease work on parts of Contract, which are affected until approval for any required modifications to construction has been obtained from Architect/Engineer.
- E Perform work with competent and skilled personnel.
- F Replace or repair, without additional compensation, any Work, which in the opinion of the Architect, does not comply with these requirements.

SECTION 3.05 INSTALLATION, GENERAL – FOR SPECIAL REQUIREMENTS REFER TO SPECIFIC EQUIPMENT UNDER OTHER SECTIONS

- A Locations of Openings:
 - 1 Locate chases, shafts and openings required for installation of electrical work during framing of structure. Do additional coring and/or cutting and patching required due to improperly located or omitted openings without cost to Owner, and with approval of Architect/Engineer.
 - 2 Coring and/or cutting or drilling in any structural member is prohibited without written approval of Architect/Engineer. No coring or cutting in any post tension slab.

- B Location of Sleeves: Wherever conduits pass through concrete walls or suspended slab, furnish and install sleeves of ample size to permit installation of conduit. Sleeves shall be installed prior to pouring of concrete and shall have ends flush with the wall or extend 2" above floor surfaces. Verify locations with Architect/Engineer.
- C Type of Sleeves: Sleeves shall be PVC, steel pipe, or galvanized sheet metal.
- D Finish Around Sleeves:
 - 1 Rough edges shall be finished smooth. Space between conduit and sleeves where conduit passes through exterior walls shall be sealed to permit movement of conduit but prevent entrance of water through the conduit sleeve. Space between conduit and sleeves where conduit passes through fire-rated interior walls and slabs shall be sealed with an U.L. approved sealing device that is fireproof and will remain pliable. Provide adequate space around conduit for device installation. Where it is impossible to install the fire seal, sleeves and slots shall be packed with approved materials to provide a fire barrier conforming to the requirements of the NFPA. All unused sleeves shall be similarly packed. Acceptable seal is Dow Corning's 3-6548 Silicone RTV Foam.
 - 2 Electrical Contractor shall be responsible for any cutting and patching which may be required for proper installation of electrical work. Work shall be performed by trade originally installing same and paid for under this section of Work.
- E Electrical equipment shall be cleaned to remove plaster, spattered paint, cement and dirt on both exterior and interior.
- F Site Cleaning: Remove from site all packing cartons, scrap materials and other rubbish relating to electrical installation daily.
- G The Electrical Contractor shall provide all pads, bases and anchors, structures, mounting hardware and accessories, required to complete the electrical work.
- H The Electrical Contractor shall provide all platforms and supporting stands for electrical equipment required to complete electrical work.
 - 1 Each piece of equipment or apparatus suspended below ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier.
 - 2 The Electrical Contractor shall exercise extreme care that such equipment does not overload structural members of the building. In all cases, the Architect/Engineer shall review details of such hangers, platforms and supports, together with the total weights of mounted equipment.

SECTION 3.06 SERVICE TIE CONNECTIONS

- A Electrical Contractor shall check and verify all voltage and phasing of service tie connections at panel board.
- B A record shall be submitted of each test made and the results submitted to the Architect/Engineer as shop drawings.
- C Phasing to be maintained shall be A, B, C, left to right, top to bottom, in all cases.

SECTION 3.07 WARRANTY

- A The Electrical contractor shall be responsible for all work installed under this specification. He shall make good, repair or replace, at his own expense as may be necessary, any defective work, materials or parts which may show themselves within one year after final acceptance, two years for ballasts with installation, if in the opinion of the Architect/Engineer said defect is due to imperfection in material, design or workmanship. Incandescent lamps are not warranted, but all shall be operating at time of final acceptance.

SECTION 3.08 INSTRUCTION PERIODS

- A Upon completion of the work and after all tests and final inspection of the work by the Authority(s) having jurisdiction, the Electrical contractor shall demonstrate and instruct the Owner's designated operating and maintenance personnel in the operation and maintenance of the various electrical systems. The Electrical contractor shall arrange scheduled instruction periods with the Owner. The Electrical contractor's representatives shall be knowledgeable in each system and supplier's representative when so specified. Scheduled Instruction periods shall be:

- 1 Service Entrance Equipment, 8 hours.

END OF SECTION

SECTION 16013

SUBMITTALS AND SUBSTITUTIONS

PART 1. GENERAL

SECTION 1.01 WORK DESCRIPTION

- A Wherever possible throughout the Contract Documents, the minimum acceptance quality of workmanship and materials has been defined either by manufacturer's name and catalog number or by reference to recognized industry standards.
- B Submittals:
 - 1. To ensure that the specified products are furnished and installed in accordance with the design intent. The Engineer has established for advance submittal of design data and for its review procedures.
 - 2. The Engineer's review of the Contractor's material submittal shall not relieve the Contractor of responsibility for errors, omission, quantities or capacities even though work is executed in accordance with the approved submittal material.
 - 3. The checking of the Contractor's material submittal is a gratuitous assistance and the Engineer does not thereby assume responsibility or liability for errors or omission. Where such errors or omissions are discovered later, the Contractor irrespective of any approval by the Engineer shall make them good since Contractor's proposal assumes a complete, operable, and acceptable installation.
- C Related Work Specified Elsewhere:
 - 1. Section 01300 – Division 1, Submittals
 - 2. Section 01630 – Division 1, Substitutions
 - 3. Section 01700 – Division 1, Project Closeout
 - 4. Section 16014 – Division 16, Project Coordination

SECTION 1.02 SUBMITTALS

- A Make all submittals of shop drawings, samples, requests for substitution, and other similar items, in strict accordance with the provisions of the Section 16013.

SECTION 1.03 DEFINITIONS

- A Shop Drawings - Original Drawings, prepared by the Contractor, subcontractor, supplier or distributor, which illustrate some portion of the Work showing fabrication, layout, setting or erection details. Shop Drawings must adhere to the following:
1. Must be prepared by a qualified detailer.
 2. Identify detail by reference to sheet and detail numbers shown on Contract Drawings.
 3. Minimum sheet size is 8 ½" x 11".
 4. Reproductions for submittals shall be reproducible transparency.
- B Product Data – Manufacturer's standard schematic drawings. The following modifications must be made by the Contractor:
1. Modify drawings to delete information, which is not applicable to this project.
 2. Supplement standard information to provide additional information applicable to project.
- C Catalog Sheets – Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive data. Catalog Sheets must adhere to the following:
1. Clearly mark each copy to identify pertinent materials, products and models.
 2. Show dimensions and clearances required.
 3. Show performance characteristics and capacities.
 4. Show wiring diagrams and controls.
- D Samples – Physical examples to illustrate materials, equipment, or workmanship and to establish standards by which completed work is judged.
1. Samples shall be of sufficient size and quantity to clearly illustrate:
 - a. Functional characteristics of product or material, with integrally related parts and attachment devices.
 - b. Full range of color samples. After review, samples may be used in construction of project.

PART 2. PRODUCTS

SECTION 2.01 SHOP DRAWINGS

- A Unless otherwise specifically directed by the Engineer, make all shop drawings accurately to a scale sufficiently large to show all pertinent features of the item and its method of connection to the Work.
- B Submit all shop drawings in the form of one vellum transparency of each sheet plus three blue line or black line prints of each sheet. Blueprint submittals will not be acceptable.

C Reproduction of Shop Drawings:

1. Printing and distribution of reviewed shop drawings to suppliers, subcontractors, and other prime contractors shall be by the Contractor in the number of copies for distribution as required.
2. For "Correct and Resubmit" shop drawings, the Engineer will:
 - a. Retain the one print of the rejected vellum for the Engineer's file.
 - b. Return the rejected vellum and additional prints of the vellum to the Contractor.
3. For "Approved as Corrected" and "Approved" shop drawings, the Engineer will:
 - a. Retain the three prints of the vellum.
 - b. Return the vellum to the Contractor.

SECTION 2.02 SUBSTITUTIONS

- A The approved "Materials and Subcontractors Listing is the essence of the contract. Substitutions of materials, equipment, etc., require the written approval of the Owner and Engineer.
- B Substitution Request:
1. The Engineer will consider proposals for substitution after Contract Award of materials, equipment and methods only when such proposals are accompanied by full and complete technical data and all other information required by the Engineer to evaluate the proposed substitution. Also submit with request, accurate cost data on the proposed substitution in comparison with the product specified and statement of whether or not modification of the Contract Sum is to be a consideration.
 2. Do not substitute materials, equipment, or methods unless the Owner and the Engineer have specifically approved such substitution for this work.
 3. For requests for substitution or approval of "equal" products prior to bid due date, see Instructions to Bidders – Article 4.
 4. Requests for substitution, when forwarded by the Contractor to the Engineer, are understood to mean that the Contractor:
 - a. Represents that he has personally investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified.
 - b. Will provide the same guarantee for the substitution that he would for that specified.
 - c. Certifies that the cost data presented is complete and includes all related costs under this Contract, but excludes costs under separate contracts and the Engineer's redesign costs, and that he waives all claims for additional costs related to the substitution which subsequently become apparent.

C Substitutions Not Considered:

1. They are indicated or implied on shop drawing submission without the formal request.
2. For their implementation they require a substantial revision of the Contract Documents in order to accommodate their use.

D Product Availability:

1. Verify prior to bidding that all specified items will be available in time for installation during orderly and timely progress of the Work.
2. In the event specified item or items will not be so available, so notify the Engineer prior to submitting a Bid Proposal.
3. Costs of delays because of non-availability of specified items, when the Contractor could have avoided such delays, will be at the expense of the Contractor.

E Reimbursement of Engineer's Costs:

1. In the event substitutions are proposed to the Engineer after the Contract has been awarded, the Engineer will record all time used by him and by his consultants in evaluation of each such proposed substitution.
2. Whether or not the Engineer approves a proposed substitution, the Contractor shall promptly, upon receipt of the Engineer billing, reimburse the Engineer at the rate of two and three-fourths the direct cost to the Engineer and his consultants for all time spent by them in evaluation of the proposed substitution.

SECTION 2.03 MANUALS

A Where operating and maintenance manuals are required to be submitted covering items included in this Work, prepare all such manuals in durable plastic binders approximately 8-1/2" x 11" in size and with at least the following:

1. Identification on, or readable through, the front cover stating general nature of the manual.
2. Neatly typewritten index near the front of the manual, furnishing immediate information as to location in the manual of all emergency data regarding the installation.
3. Complete instructions regarding operating and maintenance of all equipment involved.
4. Complete nomenclature of all replaceable parts, their part numbers, current cost, and name and address of nearest vendor of parts.
5. Copy of all guarantees and warranties issued.
6. Copy of the approved shop drawings and all data concerning all changes made during construction.
7. Where contents of manuals include manufacturers' catalog pages, clearly indicate the precise items included in this installation and delete or otherwise clearly indicate all manufacturers' data with which this installation is not concerned.

8. All material within manuals shall be new. Copies used for prior submittals or use in construction of the project is not acceptable.
9. Each Prime Contractor shall submit such manuals.

PART 3. EXECUTION

SECTION 3.01 SUBMITTALS

A Contractor's Obligations Required but not Limited to:

1. Review Shop Drawings, Project Data, and Samples prior to submission; verify the following:
 - a. Field measurements
 - b. Field construction criteria
 - c. Catalog numbers and similar data
 - d. Conformance with Specifications and Contract Drawings.
 2. Coordinate each submittal with requirements of Work and of Contract Documents.
 3. Contractor's responsibility for errors and omissions in submittals is not relieved by Engineer's review of submittals.
 4. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by Engineer's review of submittals, unless Engineer gives written acceptance of specific deviations.
 5. Notify Engineer, in writing at time of submission, of deviations in submittals from requirements of Contract Documents.
 6. Begin no work, which requires submittals until return of submittals with Engineer's stamp and initials or signature indicating review.
 7. After Engineer's review, distribute copies.
 8. Prime Contractor to process all submittals and to insure that all submittals, including those of his subcontractors, are submitted according to the Construction Schedule, and in the proper format and quantities.
- B All submittals for materials and equipment shall be made as soon as possible after award of the Contract, but not more than 35 days after the award of the Contract. In no case shall any materials or equipment be delivered to the job site until the Engineer has reviewed submittals. This requirement will be a condition for approval of subsequent Application for Payment.

C Methodology:

1. Submit product data as described below:
 - a. All submittals shall be clearly labeled as to equipment being proposed and shall be for this specific project. Data of a general nature will not be accepted. Periodic submittals of individual components within a specified section will be returned to the Contractor unapproved. All submittals shall contain complete data on each section at the time of submission for approval.
 - b. Arrange product data for submission in complete and separate sets for each Project Manual section listed.
 - c. When more than one product is specified in a specific section, a complete set of literature shall be collated into a brochure containing information on each product. When only one product is specified in a given section, a brochure is not necessary.
 - d. The first page of each brochure shall contain an index of the products enclosed in addition to all the information listed in Paragraph 3.01.5.
 - e. Number of brochures for that section shall be that which the Contractor will require for distribution plus three (3) brochures which will be retained by the Engineer.
 - f. The term "brochure" shall refer to heavy paper front and back covers with bend-over metal type fasteners designed for loose-leaf material.
2. Submit number of samples specified in each of Project Manual Section.
3. Accompany submittals with transmittal letter, in duplicate, containing:
 - a. Date
 - b. Project Title
 - c. Contractor's name and address
 - d. The quantity of each Shop Drawing, Project Data and Sample submitted
 - e. Notification of deviations from Contract Documents
 - f. Other pertinent data
4. Submittals shall include:
 - a. Date and revision dates
 - b. Project title
 - c. The names of Engineer, Contractor, Subcontractor, Supplier, Manufacturer, and separate detailer when pertinent
 - d. Identification of product or material

- e. Relation to adjacent structure or materials
- f. Field dimensions clearly identified as such
- g. Project Manual section number
- h. Applicable standards, such as ASTM number or Federal Specifications
- i. A blank space 2-1/2" x 3", for the Engineer's stamp
- j. Identification of deviations from Contract Documents
- k. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of field measurements and compliance with Contract Documents. Any materials submitted without the Contractor's stamp of approval will be returned to the Contractor for resubmission.

D Resubmission:

1. First review of the submittal will be done at no cost to the Contractor. Subsequent reviews, shall at the Engineer's option, be charged to the Contractor as hereinafter described.
 - a. Whether or not the Engineer approves a submittal, the Contractor shall promptly, upon receipt of the Engineer billing, reimburse the Engineer at the rate of two and three-fourths the direct cost to the Engineer and his consultants for all time spent by them in evaluation of the additional re-submittals.
2. Shop Drawings:
 - a. Revise initial drawings as required and resubmit as specified for initial submittal.
 - b. Indicate on Drawings any changes which have been made other than those requested by Engineer.
3. Project Data and Samples:
 - a. Submit new data and samples as required for initial submittal.

E Distribution:

1. Distribution copies of Shop Drawings and Project Data which carry the Engineer's review stamp as follows:
 - a. Contractor's file
 - b. Job site file
 - c. Other Contractors
 - d. Subcontractors
 - e. O & M Manuals
2. Distribute samples as directed by Engineer.

F Engineer's Obligation:

1. Review submittal with reasonable promptness for:
 - a. Design concept of project
 - b. Information given in Contract Documents
2. Review of separate item does not constitute review of an assembly in which item functions.
3. Affix stamp and initials or signature certifying to review of submittal.
4. Return submittals to Contractor for distribution.

SECTION 3.02 SUBMITTALS REQUIRED

A	16143	Wiring Devices
B	16170	Circuit & Motor Disconnects
C	16400	Service and Distribution
D	16470	Electrical Panelboards
E	16500	Interior Building Lighting
F	16510	Exterior Building Lighting
G	16534	Emergency Lighting Equipment
H	16536	Time Clocks
I	16721	Fire Alarm and Detection System

END OF SECTION

SECTION 16014

PROJECT COORDINATION

PART 1. GENERAL

SECTION 1.01 WORK DESCRIPTION

A Scope of Work:

1. Provide all scheduling and Work coordination between respective trades to complete Work in the most expeditious manner.
2. It is the responsibility of the Fire Protection, Plumbing, Heating and Air Conditioning, Temperature Control and Electrical Contractors to coordinate all work. Each Contractor shall coordinate space requirements and installations of Work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, conduit, etc. as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
3. Any Contractor that fails to coordinate with other trades and/or causes changes to others work because of failure to coordinate will either be required to do one or all of the following:
 - a. To remove his work and re-install it at no expense to the Owner, Architect, or Engineer.
 - b. To pay for extra work required by other trades.
 - c. To pay for any expenses that the Architect or Engineer incur with redesign, research, and inspection time.

SECTION 1.02 CONTRACTOR SUPERVISION

- A Each Contractor shall designate a superintendent who shall represent him on the Project Site. All directions given to the superintendent shall be as binding as if given to the Contractor.
- B Each Contractor shall properly man, schedule and supervise the Work to meet the Construction Schedule.
- C Each Contractor shall let sub-contracts where applicable and purchase and schedule delivery of materials to meet the Construction Schedule.

SECTION 1.03 COORDINATION

- A Each Contractor shall inspect the work of other contractors which precedes his Work and upon which his Work depends, and report to the Architect/Engineer any deviations from the Contract Documents. Failure to make an inspection and report shall constitute an accepting of the other Contractor's work.
- B Each Contractor shall coordinate and schedule his Work with the work of other Contractors to meet the Construction Schedule.

- C Notify the Architect/Engineer of any existing or foreseeable causes for delay in the Work.
- D For locations where several elements of electrical (or combined mechanical and electrical) work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings (shop drawings) showing the actual physical dimensions (at accurate scale) required for the installation. Prepare and submit coordination drawings prior to purchase/fabrication/installation of any of the elements involved in the coordination.
 - 1. Drawings will be required of the Mechanical Room on this Project.
- E Special attention is called to the following items and all conflicts shall be reported to the Architect/Engineer before installation for decision and correction:
 - 1. Locate wall switches on the "strike" side of the door where possible.
 - 2. Location of grilles, pipes, sprinkler heads, ducts and other mechanical equipment so that all electrical outlets, lighting fixtures and other electrical devices and equipment are clear from and in proper relation to these items.
- F The Electrical Contractor will not be paid for cutting, patching and finishing required for relocation of work installed due to interference between the various contractor' work.

SECTION 1.04 RELATED WORK

- A See General Construction Sections

PART 2. PRODUCTS

SECTION 2.01 MATERIALS

- A Coordinate vendors to insure timely delivery of all materials such that work proceeds without interruption.
- B Where the contract documents permit the selection from several product options, and where it becomes necessary to authorize a substitution, do not proceed with purchasing until coordination of interface requirements has been checked and satisfactorily established.

PART 3. EXECUTION

SECTION 3.01 INSTALLATION

- A Contractor shall have all labor and materials on hand and ready for installation at the proper time such that there will be no delay in the progress of the Work of other Contractors.
- B Contractor shall be responsible for coordinating and expediting the Work under his/her contract such that all Work will properly coordinate with the Work of other Contractors and can be completed on time.
- C The rejection of faulty work by the Engineer shall not relieve the Contractor of the responsibility of executing his work at the proper time.

- D Contractor shall arrange for all chases, slots, openings, trenching, etc., required for the installation of the Work under his contract and shall be held solely responsible for proper location of it.
- E Contractor shall furnish and install all sleeves required for the installation of the Work under his contract.
- F Contractor shall base all measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Contractor shall verify all measurements at the site and check the accuracy of same as related to the Work.
- G Should the Contractor discover a discrepancy between actual measurements and those indicated which prevent following good practice or the intent of the Contract Documents, he/she shall notify the Engineer and shall not proceed with his/her work until he/she has received instruction from the Engineer.
- H Contractor shall give full cooperation to other trades and shall furnish (in writing, with copies to the Engineer) any information necessary to permit the Work of all trades to be installed satisfactorily and with the least possible interference or delay.
- I Where the Work of the Contractor will be installed in close proximity to Work of other trades, or where there is evidence that the Work of the Contractor will interfere with the Work of the other trades, he/she shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor install his Work before coordinating with other trades, or so as to cause interference with Work of other trades, he shall make necessary changes in his Work to correct the conditions without additional charge.
- J Equipment, apparatus, appliances, and other items necessary and required for the adequate execution of the Work and as required by applicable Federal, State and Local Laws shall be provided by the Contractor who shall maintain them in good and safe mechanical working order, be responsible for their safe use, and remove them when no longer required. Apparatus and equipment shall be set and maintained in an orderly and efficient manner.
- K If it becomes necessary to accelerate the Work of the Contractor at any time, Contractor when so directed, shall cease work at any point and transfer his men/women to such other location or locations as may be required.
- L Contractors for the various branches of the Work shall exchange complete original and revised drawings, details, information, etc., during the progress of the job such that all installations are properly coordinated and fit together into a complete and acceptable project.
- M Contractor and all subcontractors and suppliers so requested by the Engineer, shall attend coordination meetings at the Project Site when called by the Engineer. Such meetings shall be for the purpose of discussing Work progress and schedules, resolving problems, and issuing instructions as may be required.
- N Each Contractor shall remove water from excavations and trenches as required for the performance of their work and to remove water flowing into buildings or into any other Contractor's excavation from excavations or trenches as constructed for performance of Work.

- O Each Contractor shall restore to original condition any construction of facility which may be damaged.

END OF SECTION

SECTION 16018
PROJECT CLOSEOUT

PART 1: GENERAL

1.01 WORK DESCRIPTION

A. Scope of Work:

1. Provide cleanup and submittals as required for final Project termination.

PART 2: PRODUCTS (NOT APPLICABLE)

PART 3: EXECUTION

3.01 CLEAN-UP AND FINAL INSPECTION

A. Preliminary Cleaning:

1. Near the completion of the Work and at a time directed by the Engineer, the Contractor shall vacuum clean all floors and leave other surfaces dust-free and clean.

B. Preliminary Inspection:

1. After the preliminary cleaning is complete, the Engineer will conduct a preliminary inspection. Listings of Work not acceptable to the Engineer will be issued to the Contractor for corrective action. After unacceptable Work has been corrected, the Contractor shall notify the Engineer in writing that all such unacceptable Work has been corrected. Upon receipt of such notification, the Engineer will set a date for final inspection.

C. Final Clean-up and Inspection:

1. Just prior to the date set for final inspection, the Contractor shall clean all surfaces, leaving the Work suitable in every respect for Owner occupancy.

3.02 SUBMITTALS

A. Record Drawings:

1. Furnish to the Engineer, for distribution to the Owner, the Record Drawings described in Section 16010 and 16050.

B. Documents:

1. Submit to the Engineer, in two (2) copies, for distribution to the Owner, the following documents, fully executed:

- a. Contractor's Affidavit of Payment of all Debts and Claims: AIA Document G706.
- b. Contractor's Affidavit of Release of Liens: AIA Document G706A.

c. Consent of Surety for Final Payment: AIA Document G707.

END OF SECTION

SECTION 16020

SUBCONTRACTORS AND PRODUCTS LIST

PART 1 - GENERAL

1.01- DESCRIPTION

- A. Each bidder shall furnish two copies of the following Subcontractors and Products List when submitting his bid.
- B. The Architect, Engineer, and/or Owner shall have the right to choose the subcontractor, materials or equipment for any particular item where the bidder either fails to list same or lists more than one name for the item in question.
- C. It is intended that this list will show for each contract the manufacturer and/or supplier of all major items of work that will be subcontracted and to whom.
- D. After submission of this list by the bidder and after approval of same by the Engineer and Owner, it shall not be changed unless written approval of said change is authorized by the Engineer and Owner.
- E. The list shall be submitted on forms provided and shall be completely executed. "As Specified" or "With Equipment" type terminology will not be accepted.
- F. Under Subcontractor, insert the name of the firm which bidder proposes to have perform respective work. If work will be done by the Prime Bidder and no sub-contract will be awarded, state "By Own Forces".
- G. Submission does not constitute acceptance for use of listed manufacturer's products. Materials and subcontractors are subject to provisions of general Conditions and "Standards of Product Acceptability", and must be formally reviewed and adjudged acceptable by Engineer.
- H. Engineer and Owner reserve the right to reject any submission or materials, work, or subcontract, or subcontract that does not, in their opinion, meet the requirements of drawings, specifications, or job conditions even though such materials, work or subcontract was listed and described by Bidder prior to execution of contract.
- I. All materials and subcontracts used for work on the project shall be in accordance with accepted material list.
- J. This list is intended to assure use of materials and vendors acceptably equivalent to those specified and is not a substitution sheet or complete listing of all required materials or services.

ELECTRICAL CONSTRUCTION - SUBCONTRACTORS AND PRODUCT LIST

SECTION	DESCRIPTION	SUBCONTRACTOR AND/OR SUPPLIER	PRODUCT AND/OR MANUFACTURER
16047	ELECTRICAL SYSTEM/ IDENTIFICATION		
16110	RACEWAYS AND CONDUIT		
16130	BOXES		
16143	WIRING DEVICES		
16400	SERVICE AND DISTRIBUTION		
16470	ELECTRICAL PANELBOARDS		
16500	INTERIOR BUILDING LIGHTING		
16510	EXTERIOR LIGHTING		
16535	DIMMING SYSTEM		
16536	TIME CLOCKS		
16721	FIRE ALARM & DETECTION SYSTEM		

END OF SECTION

SECTION 16021

CONCRETE WORK - ELECTRICAL

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 02210 - Site Grading.
- B. Division 3 - Concrete.
- C. Section 16450 - Grounding System.

1.02 QUALITY ASSURANCE

A. Applicable Publications.

1. The following standards of the issues listed below but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the references thereto.
 - a. American Society of Testing Materials (ASTM).
 - (1) C-94 Ready-Mixed Concrete.
 - (2) Other Publications referred to in Division 3.
 - b. Indiana State Highway Standard Specification (ISHSS).
 - (1) 1974 Edition.

B. Testing.

1. In accordance with Section 03310 - Concrete.

C. Concrete work shall be as specified and indicated utilizing the proper trades and crafts for this work.

1.03 SUBMITTALS

- A. Applicable Sections of Division 3.

1.04 PRODUCT HANDLING

- A. Applicable Sections of Division 3.

1.05 NOTIFICATION

- A. Notify the Architect when a concrete placement is scheduled so that forms, subsurface and reinforcing steel may be checked for compliance.
 1. Allow sufficient time for setters to make adjustments or corrections so that reinforcing steel correct in size, shape and position will be in place when concreting is started.

PART 2 - PRODUCTS

2.01 MATERIALS - EXTERIOR

- A. Exterior Concrete: Comply with the requirements of Division 3 and as follows:
 - 1. Ready Mixed Concrete.
 - 2. Minimum cement content: 564 lbs. per cu. yd. of concrete.
 - 3. Maximum water content: 5.5 gal. per bag of cement.
 - 4. Course aggregate shall be crushed Indiana Limestone: Maximum size 3/4 inch.
 - 5. Air entrainment: 6% + or - 1%.
 - 6. Minimum compressive strength: 4000 psi.
 - 7. Maximum slump: 4 inches.
- B. Compacted Aggregate Subbase.
 - 1. No. 53 aggregate in accordance with Indiana State Highway Standard Specification.
- C. Provide Reinforcing Steel, Welded Wire Fabric, Forms and Curing Compounds in accordance with the applicable Sections of Division 3. Minimum reinforcement shall be 6 X 6 10/10 w.w.f.

2.02 MATERIALS - INTERIOR

- A. Interior Concrete: Comply with the requirements of Division 3 and as follows:
 - 1. Ready Mixed Concrete.
 - 2. Minimum compressive strength: 3000 psi.
 - 3. Maximum slump: 4 inches.

PART 3 - EXECUTION

3.01 PADS

- A. Provide concrete pads as specified and indicated and as follows:
 - 1. For all floor mounted equipment.
 - 2. Height or thickness: 4 inches.
 - 3. Size: 4 inches larger on each side than the base of the selected equipment.
 - 4. Finish: Smooth trowelled flat surfaces and rubbed vertical surfaces. Chamfer outside corner 1 inch.

3.02 POLE BASES

- A. Provide concrete pole bases as indicated with rubbed finish.

3.03 ELECTRICAL MANHOLES

- A. Shall be constructed of concrete with reinforced top and sides. Concrete shall be 1-2-3 mixture. Frames and covers shall be of cast iron like Neenah #R1640 A or #R1865 with drop handles and bolted covers of sufficient strength for street loading. Provide pulling eye irons embedded in the wall opposite each duct entrance. Provide pulling cable racks as required on the wall, spaced not more than 3' apart, to accommodate the number of cables to be installed. End bells shall be provided in manholes for conduit entrance. All manhole hardware shall be galvanized. Cast iron covers shall be bolted in place with brass studs. Cast iron steps shall be installed as set forth above.
- B. Each manhole shall have one driven ground rod. All lead shields and all other shields where separated because of splices, etc., shall be bonded to this ground rod.

3.04 SUBGRADE PREPARATION

- A. In accordance with the requirements of Section 02210 - Site Grading.

3.05 SUBBASE PREPARATION

- A. Spread aggregate to a uniform thickness as required and compact a minimum of 05% maximum compaction. Aggregate thickness after compaction shall be minimum of four inches.

3.06 FORMWORK, REINFORCEMENT, PLACING, FINISHING, CURING AND PROTECTION

- A. In accordance with Division 3 of the Specifications and as indicated on the drawings.

END OF SECTION

SECTION 16022

ACCESS PANELS

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 08305 - Access Doors.
- B. Section 15022 - Mechanical Access Doors

1.02 DESCRIPTION

- A. Access panels not shown on the A Series Drawings and are required for access to electrical outlets, junction boxes, starters, etc., shall be provided under Division 16 of the work.
- B. The Contractor shall have the access panels installed by the proper trade. Location shall be as directed by the Architect.

1.03 SUBMITTALS

- A. Furnish complete installation drawings to the Architect for approval prior to fabrication.
 - 1. Drawings shall indicate size, material, thickness and shape, method of fabrication, installation and anchorage.

PART 2 - PRODUCTS

2.01 MATERIALS AND PRODUCTS

- A. Fire Rated Access Panels: Prime coated steel door and frame assemblies complete with flush lock release and interior latch release; 1-1/2 hour B rating, Underwriters' Laboratories, Inc.
 - 1. Standards:
 - AP-FR by Nystrom, Inc.
 - MILCOR FIRE RATED by Inland-Ryerson.
 - DBS-215 by Karp Associates, Inc.
- B. Access Panels: Prime coated steel door and frame assemblies complete with screwdriver cam locks.
 - 1. Standards:
 - MILCOR SYTLE DW by Inland-Ryerson.
 - DSC 214M by Karp Associates, Inc.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide nominal 16" x 16" access panels for devices or equipment concealed or enclosed behind walls, ceilings, bulkheads, floors and similar spaces which may require future servicing.
1. Access shall be provided for items such as outlets, junction boxes and similar items.
 2. The above listed panels are for drywall. Provide appropriate and comparable access panels by the same manufacturers for other materials.
 3. Acoustical lay-in ceilings may be utilized for access.
 4. Access doors provided by others may be utilized if access is adequate for all intended uses.
 5. Use rated panels in rated assemblies.
 6. Installation shall be in accordance with approved installation drawings.

END OF SECTION

SECTION 16023

ELECTRICAL REMOVALS AND RELOCATIONS

PART 1 GENERAL

(Not Applicable)

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

- 3.01 Perform all removal work specified and indicated on the drawings. Prepare remaining space to receive new starters and specified materials and finishes to match adjacent surfaces.
- 3.02 REMOVAL
- A Remove existing motor starter from the location indicated on the drawing which interfere with the construction of the Project. Re-install any such systems, materials and equipment which is required to complete the Project.
 - B. Where existing equipment or materials are removed or changed, all branch conduits, which are no longer in service shall be removed. All wiring shall be removed to the source. If a circuit that must remain in service is interrupted, it shall be reconnected by the most inconspicuous means so as to remain operational, with same capacity as before. All building surfaces damaged, and openings left by removal of boxes or other equipments shall be repaired. All holes left in junction boxes, switches, control panels, etc. shall be closed.
 - C. Where new openings are cut and concealed conduits etc. are encountered, they shall be removed or relocated as required. Where conduit to be removed stubs through floors, walls, and ceilings, such conduit shall be removed as to allow the finish surfaces to be patched adequately so that no evidence of the former installation remains.
- 3.04 SALVAGE
- A. All devices, fixtures, motor starters and equipment determined by the owner or his representative to be savable shall remain the property of the owner and shall be stored in a room to be designated by the owner. All unsalvagable items and debris shall be removed from the premises daily.
- 3.05 AGENCY REQUIREMENTS
- A. Requirements of Regulatory Agencies.
 - 1. Removal work and disposal of debris shall comply with all local and state requirements.
- 3.06 STREETS
- A. Do not close or obstruct streets, sidewalks or drives without permission and approval of the Construction Manager, the Owner and the local authorities.

END OF SECTION

SECTION 16024

TRENCHING, BACKFILLING AND COMPACTING
ELECTRICAL

1.01 DESCRIPTION

A. Definitions

1. Trenching, backfilling and compacting, as used in this Section, shall apply to all division 16 Work specified and indicated on the Electrical Drawings.

1.02 JOB CONDITIONS

A. Subgrade and Embankment Protection.

1. Operate pumping equipment as required to keep the excavation free of water and subgrades dry, firm and undisturbed until approval of the permanent work has been received from the Architect.
2. No material shall be installed until the trench excavation has been checked and approved, and in no case shall any material be placed on a muddy subgrade or on one containing frost.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Satisfactory soil fill materials shall be Indiana Department of Transportation (INDOT) Standard Specifications approved Grade B Borrow.
- B. Unsatisfactory soil materials are those defined in AASHTO M 145 soil classification Groups A-2-6, A-2-7, A-4, A-5, A-6 and A-7; also, peat and other highly organic soils.
- C. Subbase Materials: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slab, natural or crushed sand, as acceptable to the Architect.
- D. Capillary Water Barrier Aggregate: Washed, uniformly graded mixture of crushed stone or crushed or uncrushed gravel with 100% passing a 1-1/2-inch sieve and not more than 10% passing a No. 4 sieve (INDOT Standard Specifications No. 5 or No. 8 aggregate).
- E. Backfill and Fill Materials: Satisfactory soil materials free of clay, and free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetable and other deleterious matter.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. All items of historical value discovered during excavation shall remain the property of the Owner.

3.02 EXCAVATION:

- A. Excavating consists of removal and disposal of materials encountered when establishing required grade elevations.
- B. Excavation Classifications: The following classifications of excavation will be made when unanticipated rock excavation is encountered in the work. Do not perform such work until material to be excavated has been inspected by Architect. Such excavation will be paid on basis of contract conditions relative to changes in work.
 - 1. Earth excavation includes removal and disposal of pavements, and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of classifications indicated in data on subsurface conditions and other materials encountered that are not classified as rock excavation or unauthorized excavation.
 - 2. Rock excavation consists of removal and disposal of materials, encountered that cannot be excavated with a one-cubic-yard capacity power shovel without (drilling and blasting or) continuous use of a ripper or other special equipment, except such materials that are classified as earth excavation.
 - a. Typical of materials, classified as rock are boulders over one cu. yd. in volume, solid rock, rock in ledges and rock-hard cementitious aggregate deposits.
 - b. Intermittent drilling performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
 - c. Should rock which requires (drilling and blasting or) special equipment be encountered within the limits of required excavating, the Contractor shall so notify the Architect in writing and shall employ a licensed surveyor to take the levels of the rock after it has been uncovered but before it is removed. The total yardage of rock removed shall be certified by the surveyor.
 - d. Rock payment lines are limited to the following:
 - (1) Two feet outside of concrete work for which forms are required, except footings.
 - (2) One foot outside perimeter of footings, 6 inches below bottom of footings.
 - (3) Neat outside dimensions of concrete work where no forms are required.
 - (4) Under slabs-on-grade, 6 inches below the bottom of concrete slab.
 - 3. Unauthorized Excavation:
 - a. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction or Architect. Unauthorized excavation as well as remedial work directed by the Architect, shall be at the Contractor's expense.
 - b. Under footings, foundation bases or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footings or base to the excavation bottom, without altering top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Architect.
 - c. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect.

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4. Additional Excavation: When excavation has reached required subgrade elevations, notify the Architect who will make an inspection of conditions. If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace the excavated material as directed by the Architect.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
- D. Dewatering:
1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations.
 3. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations. If, in spite of these precautions, water rises in excavation above elevation of foundation bottom before the concrete is placed, remove not less than 8-inch depth of the affected foundation bearing soil and replace excavated material as directed by Architect.
- E. Material Storage: Stockpile satisfactory excavated materials where indicated, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations.
- F. Excavation for Structures:
1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 ft. and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction and for inspection.
 2. In excavating for footing and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.
- G. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.
- H. Excavation for Trenches:
1. Dig trenches to the uniform width required for particular size pipe to be installed, sufficiently wide to provide ample working room. Provide 6 inches to 9 inches clearance on both sides of pipe.
 2. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installation of pipe.

3. For pipes 5 inches or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe on undisturbed soil.
 4. For pipes 6 inches or larger in nominal size, excavate to subbase depth indicated, or, if not otherwise indicated, to 6 inches below bottom of work to be supported.
 5. Except as otherwise indicated, excavate so top of piping is not less than 42 inches below finished grade.
 6. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 7. Do not backfill trenches until tests and inspections have been made and backfilling has been authorized by Architect.
- I. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

3.03 EARTH FORMS:

- A. Earth may be used for footing and grade beam forms provided the soil is firm enough to hold a true shape. If such "bank forms" are used, the plan dimensions shall be 2 inches larger, both ways, than dimensions shown on Drawings. Final cut for last 4 inches in all directions shall be made by hand-excavating only. This final trimming shall be performed on the same day the concrete is placed.
- B. Should the banks cave in at any time during preparation or placing, hold footings and/or grade beams to exact size noted on Drawings with wood or metal forms.

3.04 BACKFILL AND FILL:

- A. Place acceptance soil material in layers to required subgrade elevations, for each area classification list below:
 1. In excavations and under grassed areas, use satisfactory excavated or borrow material.
 2. Under walks and pavements, use subbase material, or satisfactory excavated or borrow material, or combination of both.
 3. Under building slabs, use capillary water barrier aggregate.
 4. Under steps, use subbase material.
 5. Under piping and conduit, use subbase material where subbase is indicated under piping or conduit; shape to fit bottom 90° of cylinder.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter drainage system.

2. Inspection, testing, approval, and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structure or utilities, or leave in place if required.
5. Removal of trash and debris.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

C. Ground Surface Preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
2. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

D. Placement:

1. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
2. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
3. Place backfill and fill materials evenly adjacent to structures, piping and conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit, by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.
4. Where trench excavations pass within 18 inches of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings, backfill trenches with concrete to level of bottom of adjacent footing.

3.05 COMPACTION:

- A. Control soil compaction during construction providing minimum percentage of density specified for each area classification.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density determined in accordance with ASTM D 1557 (Modified Proctor Test).

1. Areas Under Structures, Building Slabs, Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material at 90% maximum density for cohesive material or 95% relative density for cohesionless material.
 2. Lawn and Other Unpaved Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material at 85% maximum density for cohesive soils and 90% relative density for cohesionless soils.
 3. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material at 90% maximum density for cohesive material or 95% relative density for cohesionless material.
- C. Moisture Control:
1. Where subgrade or layer of soil material must be moisture-conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in manner to prevent free water appearing on surface during or subsequent to compaction operations.

END OF SECTION

SECTION 16030

TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Test the entire electrical installation to assure compliance with the National Electric Code (NEC), other applicable codes, and proper system operation.

1.03 RELATED WORK

- A. Section 16010 - Electrical General Provisions.

1.04 TESTING AGENCY

- A. The Contractor shall retain the services of a National Electrical Testing Association (NETA) member or a firm approved by the Architect/Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS AND INSTRUMENTATION

- A. All necessary equipment, materials, and instrumentation shall be provided by and remain the property of the Testing Agency.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall perform routine insulation resistance, continuity, visual inspections, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the Testing Agency specified herein.
- B. The Contractor shall coordinate all testing for the project.
- C. The Contractor shall notify the Testing Agency when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- D. The Contractor shall notify the Architect/Engineer 10 working days prior to the performance of any test by the Testing Agency.

3.02 ELECTRICAL ACCEPTANCE TESTS

- A. General: The following equipment shall be tested in accordance with NETA's "Acceptance Testing Specifications for Electric Power Distribution Equipment & Systems," copyright 1982:
1. Low voltage cables and bus duct.
 2. Molded case circuit breakers.
 3. Instrument transformers.
 4. Metering and instrumentation (for the project, not the utility)
 5. Grounding system.
 6. Rotating Machinery.
 7. All service entrance equipment.
 8. Correct all deficiencies disclosed by the acceptance test.
- B. Circuit Tests: The Contractor shall test all wiring and connections for continuity and ground before any fixtures or other loads are connected. Tests shall be made with a 500V. minimum DC "Megger" type tester. If tests indicate faulty insulation (less than 2 megohms) such defects shall be corrected and tested again.
- C. Grounding Tests: Measure the OHMIC value of the Electric Service Entrance metallic "System Ground" with reference to "Earth Ground" using the "Multiple Ground Rod" method and suitable instruments. Maximum resistance to ground shall be less than 10 ohms. If this resistance cannot be obtained with the ground system shown, notify the Architect immediately for further instruction.
1. Confirm that the neutral is grounded only at the service equipment by removing the service neutral grounding conductor and meggering the neutral bus.
- D. Motor and Equipment Test: Check all motors and equipment for proper rotation and grounding.
- E. Cable Tests - Medium Voltage: Contractor shall retain the services of a National Electrical Testing Association member firm or approved to perform and document the required test.
1. Visual and Mechanical Inspections
 - a. Inspect exposed section for physical damage.
 - b. Verify cable is supplied and connected in accordance with the single line diagram.
 - c. Inspect for shield grounding, cable support, and termination.
 - d. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radius.
 - e. Inspect for proper fireproofing in common cable areas.

2. Electrical Tests:

Perform D.C. Hypotential Test

- a. Each conductor shall be individually tested with all other conductors grounded. All shields shall be grounded.
- b. Terminations shall be properly corona suppressed by guard ring, field reduction sphere, or other suitable methods.
- c. A D.C. hypotential shall be applied in at least eight (8) equal increments until maximum test voltage is reached. C.C. leakage current shall be recorded at each ss) versus time (X axis) shall be recorded and plotted on thirty (30) second intervals for the first two (2) minutes and every minute thereafter.
- d. A graphic plot shall be made of leakage current (X axis) versus voltage (Y axis) at each increment.
- e. The test conductor shall be raised to a maximum test voltage and held for a total of ten (10) minutes. Readings of leakage current (Y axis) versus time (X axis) shall be recorded and plotted on thirty (30) second intervals for the first two (2) minutes and every minute thereafter.
- f. The applied conductor test potential shall be slowly reduced to zero (0) and grounds applied for a period adequate to drain all stored potential.
- g. Maximum test voltages shall be in accordance with the values given below.
- h. Perform a shield continuity test by ohm meter method. Ohmic value shall be recorded.

3. Test Values

D.C. hypotential test results:

- a. Step voltage slope should be reasonably linear.
- b. Absorption slope should be flat or negative. In no case should slope exhibit positive characteristic.
- c. Maximum leakage current shall not exceed I_1 corrected to 60F where $I_1 = E/(K \text{ Log } D/d)$

K = insulation specific resistance Megohm per thousand feet at 60 F.

D = diameter over insulation

d = diameter under insulation

E = maximum test voltage

Test Voltage Table

ACCEPTANCE TEST MAXIMUM D.C. VOLTAGE

Cable Type Standard

Rubber	ICEA S-19-81	Table 6-17
Varnish Cambric	ICEA S-65-375	Table 3-4*
Thermoplastic	ICEA S-61-402	Table 6-10
Cross Linked P.E.	ICEA S-66-524	Table 6-9
Ethylene Propylene (EPR)	ICEA S-68-516	Table 6-9
Armored Cable	ICEA S-67-401	80% of factory

*For D.C. test multiply values by 2.

- F. Torque Tests: For every conductor terminated in an overcurrent device or bolted type connection; torque all connections per manufacturers recommendations and tabulate the results on a tabular form and/or copy of panel schedules.
- G. Fire Alarm Test: Test the fire alarm in the presence of a representative of the Authority Having Jurisdiction.
- H. Other System Tests: Test as indicated in individual specification sections.
- I. Test Reports: Submit to the Engineer a copy of the certified test reports for all tests noted and include copies in the O&M manual.

3.03 LABELS

- A. Apply a label certifying satisfactory test completion in accordance with NETA labeling procedure.

3.04 REPORT

- A. The Testing Agency shall submit six (6) copies of the written report in accordance with Section 16010 to the Architect/Engineer.

END OF SECTION

SECTION 16047

ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

- A. Submit samples of name plates and electrical systems painting color chips and catalog literature.

1.01 INDUSTRY STANDARDS

- A. Current editions of publications of the following institutes, are referred to in this section.

- 1. American National Standards Institutes, ANSI.

1.02 WORK INCLUDED

- A. Nameplates and tape labels.
- B. Wire and cable markers.
- C. Conduit color coding.

1.03 RELATED WORK

- A. Section 09900 - Painting

1.04 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01300.
- B. Include schedule for nameplates and tape labels.

PART 2 - PRODUCTS

2.01 MATERIALS AND PRODUCTS

- A. Nameplates: Engraved plastic laminate.
 - 1. General information - Black.
 - 2. Emergency - Red.
- B. Letters shall be white and a minimum of 3/16" high.

PART 3 - EXECUTION

3.01 NAMEPLATES

- A. Provide nameplates on all of the following devices listing the equipment controlled and the circuit feeding the device.
 - 1. Motor starters.
 - 2. Breakers and disconnect switches.
 - 3. Motor control centers
 - 4. Switchboard/panelboards
 - 5. Transformers
- B. Attach plastic laminate with metal screws on metal surfaces and with self adhesive on plastic surfaces. Attach plastic tape nameplates with self adhesive.

3.02 WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

3.03 NAMEPLATES ENGRAVING SCHEDULE

- A. Provide nameplates to identify all electrical distribution and control equipment, and loads served. Letter Height: 1/8 inch (3mm) for individual switches and loads served, 1/4 inch (6mm) for distribution and control equipment identification.

3.04 BANDING AND LABELING

- A. Color band all conduit in electrical, mechanical, fan rooms, etc., which are not color coded under this section. Label all conduit specified in this Division.
 - 1. Banding consists of providing a color coded, painted band around the conduit of sufficient width to receive specified label. Self-adhering tape conforming to ANSI A13.1 may be used in lieu of paint.
 - a. Bands shall be applied 20 feet on center along the pipe or duct, at each side of walls or floors and at junction boxes.

2. Labeling consists of providing 1/2 inch high stenciled black letters.
 - a. Apply labels at all color bands.
 - b. Labels shall be as follows:

<u>SERVICE</u>	<u>LABEL</u>
Power Wiring	Voltages
Program & Signal	Program
Fire Alarm	Fire Alarm

3.05 COLORS

- A. Colors for color bands and for color coding shall be as follows:

<u>ITEM</u>	<u>COLOR</u>
Control Voltage	Yellow
Voltages 120 to 600	Orange
Program & Signal	Gray
Fire Alarm	Red
Telephone	Black

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 INDUSTRY STANDARDS

A. Publications of the following institutes, associations, societies and agencies are referred to in this section.

1. National Fire Protection Association, NFPA.
2. American Standards Association, ASA.
3. Federal Specifications, FS.
4. Underwriters' Laboratories, UL.
5. National Electrical Manufacturers Association, NEMA.

1.01 SUBMITTALS

A. See Specification section 16013-6.3.02.A

1.02 ELECTRICAL CONNECTIONS TO EQUIPMENTS

- A. Provide power circuit conduit and wiring for all electrical equipment throughout the entire project and connect complete, unless otherwise indicated. Conduit and wiring for control and interlocking shall be provided as indicated.
- B. Motor horsepower and equipment sizes shown and specified are estimated and size of wire, conduit and circuit protection devices are based on said estimate. Ascertain the actual horsepower and current requirements of the motors and equipments to be installed, prior to beginning installations of feeders for same. If actual requirements are different and more costly, the contractor providing the equipment shall be responsible for the added cost.
- C. Certain motors such as air handling units, roof top units, make-up air units, exhaust fans & pumps have associated control switches or integral temperature switches.

PART 2 PRODUCTS

2.01 CONDUIT

- A. Raceways to be rigid steel. Conduit size will not be less than shown on the drawing. All conductors to be installed in conduit, unless specifically indicated otherwise.
- B. Rigid steel conduit shall conform to under writers' Laboratories UL-6 specification. ANSI C80.1 and Federal specification WW-C-581E or latest revision.
- C. Electrical metallic tubing shall conform to underwriter's laboratories (UL) 797, ANSI c80.3 and Federal Specifications WW-C 563 or latest revision.

- D. Flexible steel conduits (Greenfield) shall be galvanized, and where required, shall be "Sealtite" type with neoprene jacket.
- E. Non-metallic conduit shall be type 40, heavy wall PVC and shall conform to NEMA Standard TC-2 and Federal Specification WC-1094.

PART 3 EXECUTION

3.01 General requirements.

- A. Good workmanship shall be evidenced in the installation of all electrical materials and equipment. Equipment shall be level, plumb and true with the structure and other equipment; also in a horizontal or vertical position as intended. All materials shall be firmly secured in place and adequately supported and permanent. Materials embedded in concrete or masonry or otherwise part of the structure are considered sufficiently supported. All hardware and accessory fittings shall be of a type designed, intended and appropriate for use and complement the items with which they are used.
- B. All materials and equipments including any hangers, supports, fastenings or accessory fittings shall have corrosion protection suitable for the atmosphere in which they are installed whether located indoors or outdoors. Care shall be taken during the installation to assure the integrity of corrosion protection.
- C. All screws, bolts, nuts, clamps, fittings or other fastening devices shall have standard threads and heads so they may be installed and replaced when necessary without special tools.

3.03 EQUIPMENT MOUNTING

- A. Equipment may be ceiling hung, wall mounted or floor mounted as appropriate. The fasteners or supports shall be sufficient to substantially secure the equipment in place to the building structure or structural member. The supports may be catalog items or job fabricated, and shall be appropriate for the location and compatible with the equipment. They shall have corrosion protection suitable for the atmosphere. Selection of the fasteners and supports shall be based upon the strength of the materials and recognized safety factors.
- B. The equipment shall be installed plumb, true as intended and secure.
- C. When several items of equipment are wall mounted in the same area care shall be taken to line them up vertically and horizontally. Raceways to and from the equipment shall be vertical and horizontal using appropriate fittings or auxiliary gutters where necessary and practical for appearance.

3.04 SLEEVES

- A. Where electrical conduits pass through walls, roof, ceilings or floors the contractor shall have sleeves set for them when the floors, walls, ceilings or roofs are constructed.
- B. If holes are cut in existing walls, roof or floors, the cutting shall be done with a concrete coring machine or other approved method and only with the consent of the Engineer. All such holes are to be carefully cut and shall not be larger than necessary. These holes are to be entirely covered by escutcheon plates when work is completed. Sleeves shall be made of steel no lighter than #18 gauge.
- C. Where conduit pass through sleeves in exterior walls, the annular space shall be caulked with oakum

and filled inside and out with a non-hardening, waterproof sealant finished off flush with both faces of the wall.

- D. Conduits or cables passing through sleeves in floors or walls inside the building shall be sealed to prevent passage of smoke or spread of fire. This sealing material shall be a fire resistant silicone foam sealant, classified by UL.

1. Standard:

Chase Technology Corp. - CTC PR855 fire stop or equal.

3.05 ELECTRICAL POWER CONNECTION

- A. The Contractor shall prepare a work procedure for all work interrupting service to the Owner's equipment. This shall include a step-by-step procedure that the Contractor purposes to follow in the performance of this work and the time involved in each step. This procedure shall be submitted to the Engineer and Owner for approval, two weeks in advance of the performance of the work.

END OF SECTION

SECTION 16110

RACEWAYS AND CONDUITS

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 - DESCRIPTION OF WORK

- A. The work required under this section includes, but is not limited to, the provision, fabrication, and installation of all conduit required for this Work.
- B. This section covers all conduit to be used on the various portions of the Work, and the Contractor shall meet the requirements of these Specifications wherever applicable.
- C. The types of electrical raceways required for the project include the following:
 - 1. Rigid Steel - Heavy wall type conduit.
 - 2. Electrical metallic tubing.
 - 3. Flexible metal conduit.
 - 4. Underground plastic utilities duct.
 - 5. Surface mounted - wireways (plugmold/wiremold)

1.03 - RELATED WORK

- A. Section 16050 - Basic Materials & Methods.
- B. Section 16130 - Boxes
- C. Section 16450 - Grounding.

1.04 - QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.
- C. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

- D. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems: and provide products and components which have been UL-listed and labeled.
- E. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.

1.05 - PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Provide color-coded end-cap thread protectors on exposed threads of threaded metal conduit.
- B. Handle conduit and tubing carefully to prevent bending and end-damage and to avoid scoring finish.
- C. Store conduit and tubing inside and protect from weather. When necessary to store outdoors, elevate well above grade and enclose with durable, watertight wrapping.

PART 2 - PRODUCT

2.01 - GENERAL

- A. For each electrical raceway system indicated, provide a complete assembly of conduit or tubing with fittings, including, but not necessarily limited to, connectors, nipples, couplings, elbows, expansion fittings, and other components and accessories as needed to form a complete system of type indicated.
- B. Provide conduit, tubing, and raceway accessories including straps, hangers, angles, expansion and deflection fittings as recommended by conduit, tubing, and raceway manufacturers.

2.02 - RIGID STEEL CONDUIT

- A. Galvanized rigid metal conduit shall be mild steel, hot-dip galvanized conduit complying with ANSI C80.1 and Federal Specification WW-C 581 and shall be UL listed.
- B. Elbows, bends, and similar offsets shall be made of full weight material complying with the above and shall be coated and threaded the same as conduit.
- C. Threads for conduit, coupling, and fittings shall be full depth and clean cut.
- D. Conduit shall be 3/4" trade size or larger or as indicated on the drawings and shall be manufactured by National Electrical Products Company, Youngstown Steel and Tube Company, Republic Steel, Allied Steel Tube and Conduit Company, or equal.
- E. Rigid steel conduit fittings shall comply with Federal Specifications W-F-408.
 - 1. Use Type 1 fittings for rain-tight connections.
 - 2. Use type 2 fittings for concrete tight connections.
 - 3. Use type 3 fittings for other miscellaneous connections.
- F. All conduit terminations shall be equipped with locknuts and bushings. Conduits 1 1/4" and larger shall have insulating bushings and shall have locknuts inside and outside the enclosure.
- G. Conduits to be supported by wall brackets, pipe straps or trapeze hangers shall not be spaced more than 8'-0" on center. Secure supports by means of toggle bolts, inserts or expansion bolts.

2.03 - ELECTRICAL METALLIC TUBING (EMT)

- A. Electrical metallic tubing shall be mild steel, hot-dip galvanized tubing complying with ANSI C80.3 and Fed. Spec. WW-C-563 and shall be U.L. listed.
- B. Elbows, bends and similar offsets shall be made from full weight materials complying with the above and shall be coated the same as electrical metallic tubing. Use compression fittings only. **Indenter or set screw fittings are not approved.** Conduit shall be assembled with strap wrenches.
- C. Electrical metallic tubing shall be a minimum of 3/4" trade size or larger, or as indicated on the drawings.

2.04 - FLEXIBLE METAL CONDUIT

- A. All Flexible metal conduit shall be steel and comply with Fed. Spec. WW-C-566 and shall be minimum 3/4" trade size, U.L. listed, standard weight, flexible, galvanized zinc-coated steel conduit.
- B. Fittings shall be designed for use with flexible steel conduit and shall maintain electrical continuity throughout fittings and conduit. Fittings shall comply with Fed. Spec. W-F-406, Type 1, Class 1, Style A.

2.05 - NONMETALLIC CONDUIT AND DUCTS

- A. General: Provide nonmetallic conduit, ducts and fittings of types, sizes and weights (wall thickness) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portion of NEC for raceways.
- B. Electrical Plastic Conduit (EPC): NEMA Stds. Pub. No. TC 2, Type 3, Schedule 40 PVC, for direct burial, manufactured from ASTM D1784 PVC in compliance with NEMA TC-2. PVC conduit shall be U.L. listed. Joints shall be solvent cement type.
- C. Provide PVC elbows, bends, fittings, and adaptors as required for a complete installation. PVC conduit and tubing fittings shall comply with NEMA Stds. Pub. No. TC 3, match to conduit/tubing type and material. Provide solvent cement as recommended by the conduit manufacturer.
- D. Underground PVC Plastic Utilities Duct: ANSI/ASTM TC 6, Type 1 for encased burial in concrete, Type II for direct burial.
- E. PVC Plastic Utilities Duct Fittings: ANSI NEMA TC 9, match to duct type and material.
- F. Conduit, Tubing and Duct Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

PART 3 - INSTALLATION

3.01 - INSTALLATION - GENERAL

- A. Install raceway products as indicated on the drawings and as required, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure that products serve intended function.

- B. Install all conduit in building recessed in walls, floors, above false ceilings, or embedded in concrete slabs or walls, unless indicated otherwise on the drawings.
- C. Conduit field joints shall be cut square and reamed smooth. Threads shall be cleanly cut and joints drawn up tight. No running threads will be permitted.
- D. Offsets and bends shall be made carefully, without reducing cross sectional area, and shall not be less than the radius of standard elbows.
- E. Conduits above ceilings shall be supported from the structural system, not from the ceiling, ductwork, or piping suspension systems. Provide additional support at every junction box and pull box.
- F. Support single conduits 1-1/4" trade size and larger by means of rods and cast ring hangers. Support multiple runs in a similar manner or use a common trapeze hanger as required for span and loading. Provide end caps for trapeze type hangers in mechanical rooms. Conduit trapeze hangers may be fastened by means of approved heavy strap supports.
- G. Conduits surface mounted on walls up to a height of 8' above the floor shall be supported by two hole galvanized malleable pipe straps. Pinch type hangers may be used at heights greater than 8' above floor. Secure supports by means of toggle bolts, inserts, or expansion bolts.
- H. All conduits not used by this Contract shall have a No. 12 TW pull wire installed and securely tied off at each end for future conductor installation.
- I. Wherever possible, install horizontal raceway runs above water and steam piping.
- J. All conduit runs shall be grounded in an effective and approved manner at point of origin and shall contain a continuous Code sized ground (copper conductor) throughout all runs, cabinets, pull boxes, and fittings from point of service to all outlets.
- K. Conduits concealed in concrete shall be secured in place during placing of concrete. Conduit shall not be installed in floor slabs less than 3-1/2" thick. Conduit shall have 1-1/2" of concrete cover on all sides.
- L. All runs shall be completed, clean and free from foreign matter inside before the conductors are drawn in. During the installation, conduit ends are to be plugged or capped to prevent the entrance of foreign materials.
- M. Conduits shall be supported by wall brackets, pipe straps, or trapeze hangers spaced in accordance with the National Electric Code. Secure supports by means of toggle bolts, inserts, or expansion bolts in masonry surfaces.
- N. Conduit fittings similar to conduit type shall be used as required to keep conduits close to the building surface.
- O. Make joints in PVC conduit in compliance with the manufacturer's instructions. Make all bends by means of an electrical heating unit approved by the conduit manufacturer where standard elbows and fittings cannot be used.
- P. Install raceways that stub up through floor at such depth at the exposed raceway is vertical and no curved section of the elbow is visible.

- Q. Where shown on the drawings, install metal surface raceway parallel to a building surface (i.e., wall, ceiling, floor). Fasten to surface as recommended by manufacturer. Mount so raceway is in the least obvious location.
- R. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components with other work.
- S. Level and square raceway runs, and install at proper elevations/heights.

- T. Complete installation of electrical raceways before starting installation of cable/wires within raceways.
- U. Provide marker tape over all underground raceways. Marker tape shall read "CAUTION - ELECTRICAL LINE BURIED BELOW" as manufactured by Terra Tape or similar. Marker tape shall be installed 1'-0" below grade.

3.02 - RACEWAY USAGE

- A. All conduit shall be electrical metallic tubing (E.M.T.), except in concrete slabs, and in earth or below grade and or otherwise noted.
- B. Where conduit is installed in earth, it shall be PVC conduit.
- C. Galvanized rigid or polyvinyl chloride (PVC) conduit shall be used in concrete slabs.
- D. Provide flexible conduit for motor connections, and for other electrical equipment connections where subjected to movement and vibrations but no longer than five feet.
- E. Flexible steel conduit may be used in lengths no longer than 6' for connection to recessed light fixtures.

3.03 - RACEWAY SEALS

- A. Seal interior of all raceways which pass through building roof or through outside walls of the building, above or below grade. Seal on the end inside the building, using raceway sealing fittings manufactured for the purpose.
- B. Provide gas-tight and watertight seals at all underground building entries. Provide seals between wall and conduit and between conduit and conductors.
- C. Roofs: Provide mopped, lead, roof jack where raceway penetrates roof membrane.
- D. Fire Rated Construction: All penetrations shall be sealed to maintain fire rating of construction penetrated. Caulk around penetration with Dow Corning Silicone RTV foam as recommended by manufacturer, or use other approved method acceptable to the Architect.

3.04 - SERVICE ENTRANCE RACEWAY

- A. Coordinate with power company and install raceways in accordance with their requirements.
- B. High voltage conduit shall be PVC.
- C. Arrange and slope raceways entering building to drain away from building.
- D. Install underground raceways a minimum of 24" below final grade, unless otherwise noted on the drawings or required by Code.

3.05 - RACEWAYS UNDERGROUND

- A. Shall be rigid galvanized steel painted with two coats of bitumastic paint; or rigid galvanized steel with a 15 mil. PVC jacket (repair abrasions with PVC base paint).

- B. Arrange and slope raceways entering building to drain away from building.
- C. Provide marker tape over all underground raceways. Marker tape shall read "CAUTION - ELECTRIC LINE BURIED BELOW" as manufactured by Terra Tape or similar. Marker tape shall be installed 1'-0" below grade.
- D. Install underground raceways a minimum of 24" below final grade unless otherwise noted on the drawings or required by Code.
- E. Provide backfill around underground raceways. Use material size of "pea gravel" or smaller to 3" above and below raceways. Backfill to 12" above raceways shall be free of debris or rocks greater than 1" in diameter.

3.06 - SEISMIC REQUIREMENTS

- A. Raceway installation for the work shall meet all applicable code seismic requirements.

3.07 - ADJUSTING AND CLEANING

- A. After concrete is placed for underfloor ducts, bring marker screws to finished concrete level to be used as screed when smoothing finished floor. Utilizing adjusting screws, bring up access unit tops to screed line (finished concrete level).
- B. Upon completion of installation of raceways, inspect interiors of raceways; remove burrs, dirt and construction debris.

3.08 - ESCUTCHEONS

- A. Escutcheons shall be installed on conduit, or devices where they pass through floors, ceilings or walls or partitions in finished areas.
- B. The interior of closets, janitors closets, and storage closets adjacent to finished areas shall be considered as finished for the intent of these specification.
- C. Escutcheons shall be one piece where practicable, or split, hinged, stamped brass type designed to fit the conduit, and to cover the terminating sleeve, in chrome plated finish, unless otherwise specified, with securing device to hold the escutcheon tight to the conduit.
- D. Use waterproof deep escutcheon on each set sleeve in finished waterproof floor above grade.
- E. Caulk annular space between sleeve and conduit.

3.09 - RACEWAY COLOR CODING

- A. For Fire Alarm , Provide a Red 3" wide color coded band at 50 foot intervals and at all terminations (including junction and pull boxes) identifying the raceway's wiring system. Color band may be enamel paint or 1/2" tape.

END OF SECTION

SECTION 16120

WIRES AND CABLES (600V AND BELOW) AND CONNECTORS

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a part of each Division-15 and -16 section making reference to electrical wires and cables specified herein.

1.02 - DESCRIPTION OF WORK

- A. Extent of electrical wire and cable work is indicated by drawings and schedules.
- B. Types of wire, cable and connectors specified in this section include the following:
 - 1. Copper conductors.
 - 2. Fixture wires.
 - 3. Tap type connectors.
 - 4. Split-bolt connectors.
 - 5. Wirenut connectors.
 - 6. Compression Type.
- C. Signal type wire and cable products are not part of this Section
- D. Applications of electrical wire, cable and connectors required for project are as follows:
 - 1. For power distribution circuitry.
 - 2. For lighting circuitry.
 - 3. For appliance and equipment circuitry.
 - 4. For motor-branch circuitry.
 - 5. For control applications

1.03 - QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than

5 years.

- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to those required for project.
- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation of color coding of electrical wires and cable.
- D. UL Compliance: Comply with applicable requirements of UL Std. 83, "Thermoplastic-Insulated Wires and Cables", and Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", except where manufacturer's torque tightening requirements are more stringent." Where applicable, also comply with:
 - 1. UL44: Rubber-Insulated Wires and Cables.
 - 2. UL 493: Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
- E. UL Labels: Provide wiring/cabling and connector products which are UL and labeled.
- F. NEMA/ICEA Compliance: Comply with NEMA/ICEA Std Pub/No. `s WC 5, "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy", and WC-30, "Color Coding of Wires and Cables", pertaining to electrical power type wires and cables.
- G. IEEE Compliance: Comply with applicable requirements of IEEE Stds 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors", and Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to wiring systems.
- H. ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8 and D-753. Provide copper conductors with conductivity of not less than 98% at 20 °C.(68 ° F.).

1.04 - SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

1.05 - DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type non-returnable wire and cable reels.
- B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

1.01 - ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Wire and Cable:

1. Apex Wire and Cable Corp.
2. American Insulated Wire Corp.
3. American Wire and Cable Co.
4. Anaconda-Ericsson Inc; Wire and Cable Div.
5. Belden Div; Cooper Industries.
6. Brad-Rex Div; Pyle National Co.
7. Cerro Wire and Cable Co.
8. Cleveland Insulated Wire Co.
9. General Cable Corp.
10. Helix Wire Corporation..
11. Hitemp Wires, Inc.
12. Indiana Insulated Wire Inc.
13. Madison Wire and Cable Corp.
14. Phelps Dodge Cable and Wire Co.
15. Pirelli Cable Corp.
16. Radix Wire Co.
17. Rome Cable Corp.
18. Southwire Company.
19. Triangle PWC, Inc.

Connectors:

1. AMP, Inc.
2. Appleton Electric Co; Emerson Electric Co.
3. Burndy Corporation
4. Brand-Rex Div., Pyle National Co.
5. Electrical Products Div.; Midland-Ross Corp.
6. General Electric Co.
7. Gould, Inc.
8. Ideal Industries, Inc.
9. Leviton Mfg. Company.
10. 3M Company
11. O-Z/Gedney Co.
12. Southport Industries, Inc.
13. Square D Company
14. Thomas and Betts Corp.

2.02 - WIRES, CABLES AND CONNECTORS

- A. General: Provide electrical wires, cables and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated.
- B. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20 ° C (68 ° F).
- C. Building Wires: Provide factory-fabricated wire of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements. Conductors shall be annealed copper.
 1. Type THW: For wet and dry locations; min operating temperature 75 ° C. Insulation, flame-retardant, moisture and heat-resistant, thermoplastic.
 2. Type THHN/THWN : For wet and dry locations; min operating temperature 90 ° C. Insulation, flame-retardant, moisture and heat resistant, thermoplastic with nylon jacket.

- D. Check with manufacturer's representative and NEC to ensure conductor and sheathing types are compatible and are being manufactured (with off-the-shelf availability).
- E. THHN/THWN: #12 through #8AWG and THW may be used for #6AWG and larger.

2.03 - CONNECTORS

- A. General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, material, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements NEC and NEMA standards. Ensure connector materials mate and match and are compatible with conductor materials and cables. Select from the following types, classes, kinds and styles:
 - 1. Type: Pressure
 - 2. Class: Insulated.
 - 3. Kind: Copper (for Cu to Cu connection).
 - 4. Style: Butt connection
 - 5. Style: Elbow connection.
 - 6. Style: Combined "T" and straight connection.
 - 7. Style: "T" connection.
 - 8. Style: Split-bolt parallel connection.
 - 9. Style: Tap connection.

PART 3 - EXECUTION

3.01 - INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.
- C. Install UL Type THHN/THWN wiring in conduit, for feeders and branch circuits.
- D. Pull conductors together where more than one is being installed in a raceway.
- E. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation. Use of soap is not permitted as a pulling lubricant.
- F. Use pulling means, including fish tape, cable, rope and basket weave wire/cable grips which cannot damage cables or raceway.

- G. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
- H. Keep conductor splices to minimum.
- I. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductor being spliced.
- J. Use splice and tap connectors which are compatible with conductor material.
- K. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

3.02 - FIELD QUALITY CONTROL

- A. Prior to energizing circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units and re-test to demonstrate compliance.

END OF SECTION

SECTION 16130

BOXES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.

1.02 REFERENCES

- A. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

PART 2 - PRODUCTS

2.01 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Cast Boxes: Cast ferrous alloy, shallow/deep type as meet installation requirements, gasketed cover, threaded hubs where required.

2.02 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes; ANSI/NEMA OS 1; galvanized steel.
- B. Sheet Metal Boxes Larger Than 12 Inches (300 mm) in Any Dimension: Hinged enclosure.
- C. Cast Metal boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box. UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, outside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Fiberglass Handholes for Underground Installations: Die-molded with pre-cut 6 x 6 inch (150 x 150 mm) cable entrance at center bottom of each side; fiberglass weatherproof cover with non-skid finish.

PART 3 - EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Verify location of outlets, switches and junction box in finished rooms with DESIGNER drawings of interior details and finish. In centering outlets and locating boxes allow for overhead pipes, ducts and mechanical equipment, variations in fireproofing and plastering, window and like, and correct any inaccuracy without

expense to the Owner.

1. Heights of Outlets Above Finish Floor (A.F.F.) (Heights given are to center of outlet)

Generally as follows:

- a. Receptacles, general: 1' - 6"
- b. Receptacles over workbenches, tables, etc., excepts as indicated: 3' - 8".
- c. Telephone outlets: 1' - 6"
- d. Telephone outlets over workbenches, tables, etc., except as indicated: 3' - 8"
- e. Wall switches, general: 4' - 0"
- f. Wall push buttons: 4' - 0"
- g. Motor Controllers: 4' - 0"
- h. Clocks: 7' - 6"
- i. Manual Fire Pull: Maximum height is 48" above finished floor (ADA)
- j. Horn /Strobes: 80" above highest floor level or 6" below ceiling (whichever is lower) (ADA)

Exceptions to the Above Heights:

- k. At junction of different material in wall finishes.
 - l. Where outlets would occur in moldings, break in wall surface or unsuitable location in tile, wood or similar finish.
 - m. Where outlets would conflict with locations of wall mounted equipment, such as radiators, convectors, unit heaters and like.
 - n. As noted or directed otherwise.
- C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of boxes and outlets in offices and work areas prior to rough-in.
- D. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors with Section 08305.
- E. Locate and install to maintain headroom and to present a neat appearance.

3.02 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (160 mm) separation in acoustic-rated walls.
- B. Cut and locate boxes in masonry walls at required height and location. Coordinate masonry cutting to

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achieve neat openings for boxes.

- C. Provide knockout closures for unused openings.
- D. Support boxes independently of conduit except for cast boxes that are connected to rigid metal conduits, provide support for both installations within 12 inches of boxes.
- E. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes.
- F. Install boxes in walls without damaging wall insulation.
- G. Coordinate mounting heights and locations of switch and receptacle mounted above finished floor (A.F.F.).
- H. Position outlets to locate luminaries as shown on reflected ceiling plans.
- I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.
- J. Provide recessed outlet boxes in finished areas; secure Boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- L. Provide cast outlet boxes in exterior locations exposed to the weather and wet locations.
- M. Wiring of different voltages must be kept in separate boxes.

3.03 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas. Covers furnished with proper number of screws.
- B. Support pull and junction boxes independent of conduit.
- C. Covers shall be accessible.
- D. Splicing boxes for fixtures, recessed in hung ceilings shall be accessible through opening created by removal of the fixture.

END OF SECTION

SECTION 16142

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is a Division 16 Basic Electrical Materials and Methods section, and is part of each Division 15 and 16 section making reference to electrical connections for equipment specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment. Control and signal type terminal connections are not specified in this section.
- B. Application of electrical power connections specified in this section include the following:
 - 1. To resistive heaters.
 - 2. From electrical source to motor starters.
 - 3. From motor starters to motors.
 - 4. To lighting fixtures.
 - 5. To grounds including earthing connections.
- C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division 15 and other Division 16 sections, and are work of this section.
- D. Refer to Division 15 sections for motor starter and controllers furnished integrally with equipment; not work of this section.
- E. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are work of this section.
- F. Electrical identification for wire/cable conductors is specified in Division 16 section, "Electrical Identification", and is work of this section.
- G. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are work of this section.
- H. Refer to Division 15 sections for control system wiring; not work of this section.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years. Connectors and terminals supplies by equipment manufacturers shall also meet these requirements.
- B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.
- C. NEC Compliance: Comply with applicable requirements of NEC, including NEC Article 110-14, "Electrical Connections," as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.
- D. IEEE Compliance: Comply with Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
- E. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
- F. UL Compliance: Comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and -labeled.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.
- B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.
- C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Adalet-PLM Div, Scott and Fetzer Co.
 - 2. Allen-Stevens Conduit Fittings Corp.
 - 3. AMP Incorporated.
 - 4. Appleton Electric Co.

5. Arrow-Hart Div, Crouse-Hinds Co.
6. Atlas Technologies, Inc.
7. Bishop Div, General Signal Corp.
8. Burndy Corporation.
9. Eagle Electric Mfg Co.
10. Electroline Mfg Co.
11. Gardner Bender, Inc.
12. General Electric Co.
13. Gould, Inc.
14. Harvey Hubbell Inc.
15. Ideal Industries, Inc.
16. Pyle National Co.
17. Reliable Electric Co.
18. Square D Company
19. Thomas and Betts Corp.

2.02 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

2.03 METAL CONDUIT, TUBING AND FITTINGS

- A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division 16 basic electrical materials and methods section "Raceways", and in accordance with the following listing of metal conduit, tubing and fittings:
 1. Rigid steel conduit - GRS.
 2. Rigid metal conduit fittings.
 3. Electrical conduit fittings EMT.

4. EMT fittings.
5. Intermediate metal conduit - IMC.
6. Intermediate metal conduit fittings.

2.04 WIRES, CABLES, AND CONNECTORS

- A. General: Provide wires, cables, and connectors complying with Division 16 basic electrical material and methods section "Wires and Cables".
- B. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power.
 1. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- C. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and which are recommended by equipment manufacturer for intended applications.
- D. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

- E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque-tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A for copper conductors.
- I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- J. Fasten identification markers to each electrical power supply wire/cable conductor, except where color-coded conductors are used, which indicates voltage, phase and feeder number in accordance with Division 16 section : "Electrical Identification". Affix markers on each terminal conductor, as close as possible to the point of connection.

3.03 FIELD QUALITY CONTROL

Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION

SECTION 16143

WIRING DEVICES

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.
- B. This section is a Division 16 Basic Material and Methods section, and is apart of each Division 16 section making reference to wiring devices specified herein.

1.02 - DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. GFCI receptacles.
 - 2. Switches.
 - 3. Wall plates.
 - 4. Plugs and connectors.

1.03 - QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.
- B. NEC Compliance: Comply with NEC as applicable to installation and wiring devices.
- C. UL Compliance: Comply with applicable requirements of UL 20, "General-Use Snap Switches"; 486A "Wire Connectors and Soldering Lugs for Use With Copper Conductors"; 498, "Electrical Attachment Plugs and Receptacles"; and 943, "Ground Fault Circuit Interrupters" pertaining to installation of wiring devices. Provide wiring devices which are UL-listed and labeled.
- D. IEEE Compliance: Comply with applicable requirements of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electrical wiring systems.
- E. NEMA Compliance: Comply with applicable portions of NEMA Stds Pub/ No. WD 1, "General-Purpose Wiring Devices", WD 2, "Semiconductor Dimmers for Incandescent Lamps", and WD 5, "Specific-Purpose Wiring Devices".

1.04 - SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical wiring devices.

PART 2 - PRODUCTS

2.01 - ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering wiring devices which may be incorporated in the work include, but are not limited to, the following:
1. Appleton Electric Co.
 2. Cutler-Hammer Inc.
 3. Eagle Electric Mfg. Co.
 4. General Electric Co.
 5. GTE Products Corp.
 6. Harvey Hubbell Inc.
 7. Leviton Mfg. Co.
 8. Pass and Seymour, Inc.
 9. Square D Co.
 10. Thomas and Betts Corp.
 11. Wiremold Company

2.02 - FABRICATED WIRING DEVICES

- A. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Stds. Pub No. WD 1. Provide ivory color devices and wallplates except as otherwise indicated; color and style selection to be verified by Contractor with Architect/Engineer.

2.03 - RECEPTACLES

- A. Heavy-Duty Duplex: Provide heavy-duty receptacles, 2-pole, 3-wire grounding, 15-amperes, 125 volts, with metal plaster ears, design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.
- B. Ground-Fault Interrupters: Provide ground-fault circuit interrupters, with heavy-duty duplex receptacles, installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20-amperes, 120 volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; equip with NEMA 5-20R.
- C. Decorator Ground Fault Circuit Interrupter and Surge Protection Receptacles: Provide receptacle equal to

Eagle #647-2v/1G1210V, with full surge protection 20A-125V NEMA 5-20R.

2.04 - PLUGS AND CONNECTORS

- A. Plugs: Provide 20-amperes, 125-volts, 4-wire grounding, armored cap plugs, parallel blades with cord clamp, and 0.4" cord hold; match NEMA configuration with power source's.
- B. Connectors: Provide 20 amperes, 125 volts, bakelite-body armored connectors, 4-wire grounding, parallel blades, double wipe contact, with cord clamp, and 0.4" cord hold; match NEMA configuration with mating plug's.

2.05 - SWITCHES

- A. Snap: Provide heavy-duty flush single-pole toggle switches, 20-amperes, 120 volts AC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, and side-wired screw terminals.
- B. Three Way: Provide heavy duty flush 3-way AC switches, 20 amperes, 120 volts, with mounting yoke insulated from mechanism, equipped with plaster ears, lock type switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.

2.06 - WIRING DEVICE ACCESSORIES

- A. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; wallplates colored to match wiring devices. Provide plates possessing the following additional construction features or consult for color, type and style:
 - 1. Material and Finish: Plastic, smooth.
- B. Outdoor or weatherproof plates: Cast Aluminum, gasketed with spring loaded, corrosion resistant gasketed door, plates for duplex receptacles shall be mounted horizontally and provided with a common cover.

PART 3 - EXECUTION

3.01 - INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated, in accordance with manufacturer's written instruction, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.
- C. Install wiring devices only in electrical boxes which are clean; free from excess building material, dirt, and debris.
- D. Install galvanized steel wallplates in unfinished spaces.
- E. Install wiring devices after wiring work is completed.

- F. Install wallplates after painting work is completed.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A. Use properly scaled torque indicating hand tool.
- H. Device Circuit Identification:
 - 1. Each wiring device shall be permanently labeled on the front, with the circuit number supplying power to the device.
 - a. Provide wire markers affixed to each conductor within the junction box supporting the device.

3.02 - PROTECTION OF WALL PLATES AND RECEPTACLES

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

3.03 - GROUNDING

- A. Provide equipment grounding connection for wiring devices, unless otherwise indicated. Tighten connection to comply with tightening torques specified in US Std 486A to assure permanent and effective grounds.

3.04 - TESTING

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION

SECTION 16170

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 16 Basic Electrical Materials and Methods sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of circuit and motor disconnect switch is indicated on drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following:
 - 1. Equipment disconnects.
 - 2. Appliance disconnects.
 - 3. Motor-circuit disconnects.
- C. Wire/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Division 16 Basic Electrical Materials and Methods sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of circuit and motor disconnect switches of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing circuit and motor disconnect work similar to that required for this project.
- C. NEC Compliance: Comply with NEC requirements, including Article 430, pertaining to construction and installation of electrical circuit and motor disconnect devices.
- D. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches". Provide circuit and motor disconnect switches which have been UL-listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches.
- B. Shop Drawings: Submit shop drawings of electrical circuit and motor disconnect switches showing accurately scaled switches, their layouts and proximity to associated equipment or provide coordination
Design-Aire Engineering, Inc.

type shop drawings as required in electrical general provisions.

- C. Wiring Diagrams: Submit power and control wiring diagrams for circuit and motor disconnects, including connections to power and control panels, and feeders.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering circuit and motor disconnects which may be incorporated in the work include:
 1. Crouse-Hinds Co.
 2. Cutler-Hammer Inc.
 3. Federal Pacific Electric Co.
 4. Furnas Electric Co.
 5. General Electric Co.
 6. General Switch Corp.
 7. GTE Sylvania Inc.
 8. Square D Company.
 9. Westinghouse Electric Corp. (EATON)

2.02 FABRICATED SWITCHES

- A. General-Duty Disconnect Switches: Provide surface-mounted, general-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; and incorporating spring assisted, quick-make, quick-break switches which are so constructed that switch blades are visible in OFF position with door open. Motor-circuit disconnect switches must be HP rated. Equipped with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is capable of being padlocked in OFF position.
- B. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and stamped enclosure knockouts.
- C. Provide NEMA 1 type enclosures unless noted otherwise.

PART 3 - EXECUTION

3.01 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES.

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated and allowed by NEC for motors larger than 1/8 HP.

3.02 GROUNDING

Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical disconnect switches where indicated.

3.03 FIELD QUALITY CONTROL

Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION

SECTION 16400

SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 16050 - Basic Materials and Methods.

B. Section 16120 - Raceways and Conduit

C. Section 16450 - Grounding.

1.02 INDUSTRY STANDARDS

A. Equipment specified herein shall meet the applicable standards of the following agencies and associations:

1. Underwriter's Laboratories, UL.
2. Institute of Electrical Manufacturers Association, IEEEA.
3. National Electrical Manufacturers Association, NEMA.

1.03 SUBMITTALS

A. Furnish to the Architect shop drawings for the following items:

1. Switchboard and related components.
2. Safety switches.

PART 2

2.01 SWITCHBOARDS

A. ACCEPTABLE MANUFACTURERS

1. General Electric Company
2. Square D Company
3. Cutler - Hammer
4. Westinghouse

2.02 - GENERAL

A. Short circuit current rating: Switchboards shall have a minimum short circuit current rating of 65,000 Amps or as shown on the One Line diagram (rms symmetrical amperes at 480 volts AC maximum).

- B. Future Provisions: All unused spaces provided, unless otherwise specified shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
 - c. Enclosure:
 - 1. Align Sections at front and rear.
 - 2. Switchboards shall be of dead front construction.
 - 3. The switchboard frame shall be of formed UL gauge steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.
 - 4. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
 - 5. Each switchboard section shall have a barriered bottom and an individually removable top plate for installation and termination of conduit.
 - 6. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be medium light gray, ANSI #49, applied by the Electro-deposition process over an iron phosphate pretreatment.
 - 7. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
 - 8. Top and bottom conduit areas shall be clearly indicated on shop drawings.
 - D. Nameplates - Provide 1" H x 4" W engraved laminated (Gravoply) Nameplates for each device. Finish black letters on a white background for 208/120-volt service.
 - E. Bus Composition Plating shall be applied continuously to all bus work. The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 temperature rise requirements. The phase and neutral through-bus shall have an ampacity as shown in the plans. For 4-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.
 - F. Bus Connections - shall be bolted with Grade 5 bolts and conical spring washers. Welded connections are not acceptable.
 - G. Ground bus - sized by NFPA 70 and UL 891 Tables 25.1 and 25.2 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided as outlined above.
 - H. Accessibility - accessible fronts and rears of switchboard.
 - I. Ground Fault Protection shall be provided per NEC.
 - J. Main Circuit Breaker in switchboard shall be 100% rated.
- 2.03 CIRCUIT BREAKERS - MOLDED CASE
- A. These units shall be single or multi-pole as required and shall have a quick-make, quick-break mechanism.

- B. Breakers shall have overload elements of the thermal magnetic type that provides inverse time delay and instantaneous short circuit protection. Each pole of a breaker shall contain an overload element. Multi-pole units shall have a common tripping mechanism. Tie-bars are not allowed.
- C. Breakers shall have a toggle type handle with 3 positions indicating "on", "off", or "tripped". A breaker tripping on overload shall be clearly indicated by the handle assuming a midway position between "on" and "off".
- D. All breakers shall be bolt-in type and shall be full size single units. Duplex or Tandem type breakers are not acceptable.
- E. Trip rating and other interrupting requirements shall be as shown on the drawings. Minimum interrupting capacity shall be 65,000 amps.
- F. Breakers shall be as manufactured by ITE/Siemens Allis, Square D, or General Electric.

2.04 SAFETY SWITCHES (DISCONNECTS)

- A. Safety switches shall be heavy duty, fused unless noted otherwise, with number of poles, electrical characteristics, ratings and modifications as required. When used as service entrance equipment unit shall be labeled as such.
- B. Switching mechanism shall be quick-make, quick-break, with handle that is padlockable in the "off" position.
- C. Enclosure shall be suitable for the area in which it is to be installed and shall have defeatable door interlock, which prevents the door from opening when the switch is "on".
- D. Fusible units which are to be equipped with current limiting fuses shall have fuseholders with rejection clips to prevent other type fuses from being installed.
- E. Safety switches shall be as manufactured by, Cuttler-Hammer, Westinghouse, Square D, or General Electric.

2.07 FUSES

- A. Fuses shall be non-renewable with 200,000 amperes RMS symmetrical interrupting capacity.
 - 1. Class RK5 units shall be non-renewable, time-delay type:
 - a. Standards:
 - Low-Peak; LPN-RK, LPS-RK, Limitron; KTN-R, KTS-R, Fusetron; FRN-R, AND FRS-R -Bussman Co.
 - Amp-Trap; A2D-R and A6D-R-Ferraz Shawmut Inc.
 - 2. Class L units.
 - a. Standards:
 - LIMITRON; KRP-C-Bussman Co.

AMP-TRAP;A4BY- Ferraz Shawmut Inc.

3. Class J Units.

a. Standards:

Limitron; JKS-Bussman Co.

Amp-Trap; A4J- Ferraz Shawmut Inc.

- B. Provide the Owner with 10% or three (3) spare fuses, whichever is greater, of each size and type used on the project.

PART 3-EXECUTION

3.01 INSTALLATION

- A. Safety switches shall be installed where shown at 6' from floor to top of switch, unless otherwise noted.
- B. Install all items securely to walls, columns, or machine frames, and be responsible for all necessary brackets, mounting devices, structural pieces, anchors and/or inserts necessary for this purpose.
- C. Do not mount equipment directly to masonry or concrete walls. Provide a 3/4" plywood panel on the wall and securely mount equipment on the plywood.

END OF SECTION

SECTION 16401

TESTING AND SERVICING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Test and inspect all existing feeder cables, branch circuit wiring, and motors left in place, and new feeder cables and motors.
- B. Inspect, clean, lubricate, and test all existing power circuit breakers and oil circuit breakers that are reused.
- C. Provide all test instruments and the services of an electrical equipment manufacturer's field engineering and maintenance services organization.

1.02 RESPONSIBILITY

- A. Be responsible for all tests and test records. Testing shall be performed under the immediate supervision of the Construction Manager.
- B. Provide records of all tests and inspections, with complete data on all readings taken, and incorporate into a report. A copy of all test reports shall be delivered to the Construction Manager at the end of each test period.
- C. The sequence of tests shall be arranged so that the equipment can be energized immediately after completion of the applicable tests.
- D. Schedule all tests and get approval of the Construction Manager. No testing shall be done without this clearance.
- E. Visually inspect all equipment immediately prior to the energizing of that equipment.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 TESTING

- A. The insulation tests (megger tests) as hereinafter specified are the minimum readings desired at an ambient temperature of 60 degree F. (15.56 degrees C) and at a low relative humidity. Megger readings taken at other than ambient temperature of 60 degrees F. shall be corrected to 60 degrees F. When megger readings fall below the specified minimum values, devise some means of applying heat for the purpose of drying out the equipment. The method devised must be approved by the Architect.
- B. Power Cables - 240 volt service and lower: Test all 240 volt power service cables and leads for continuity and perform a megger test to ground between cables using a 1000 volt motor driven megger.

- C. Power Cables - 500 volts: Give each K V rated cable a high potential test. Apply alternating or direct current voltage between each conductor at one terminal and the other terminal consisting of the ground, the sheaths or shields of wires and cables connected together. Use the method, voltage, length of time, and other test characteristics in accordance with the specification for the type of cable involved.
- D. All cable connections must pass a visual inspection for workmanship and conformance with standard practice.
- E. Check continuity by means of a D.C. test device using a bell or buzzer.
- F. Perform megger tests between one conductor and ground with the other conductors grounded. Each conductor shall be tested in the same manner. The minimum acceptable megger reading for disconnected cables shall be 100 megohms. Megger reading for disconnected cables shall be 100 megohms. Megger readings for cables connected at both ends shall be recorded. Cable shall be disconnected and tested if the Architect considers it necessary. If any cable has a megger reading markedly lower than average, even though meeting minimum requirements, notify the Architect for further instructions.
- G. Rotating Equipment: All rotating equipment shall pass a minimum megger reading with the windings at ambient temperature. Any machine not passing this test shall be dried and retested until it either passes or is found unsatisfactory. During installation all motors shall be inspected for damage, moisture, alignment, proper lubrication, oil leaks, phase identification and cleanliness. Means shall be taken to check proper rotation. For three phase motors, megger tests shall be applied between all phases tied together and ground and shall include cable back to the open starter. The minimum megger readings shall be as follows:

Minimum Megger		
Equipment	Megger Voltage	Reading - Megaohms
208 V. 3 phase Ind. Motor	500	5
120 V. Ind. Motor	500	1

- H. Hold megger tests for one (1) minute or until the reading maintains a constant value for fifteen (15) seconds.
- I. Record all megger readings and ambient temperatures at the time of test.
- J. Final acceptance of rotating equipment cannot be made until the equipment is energized during operational test. Tests with each machine mechanically uncoupled (where reverse rotation could damage equipment) shall prove proper rotation, lubrication and alignment. The machine under test shall not have excessive vibration.

3.02 EQUIPMENT APPRAISAL AND TESTING

- A. Switchgear equipment and power circuit breaker - low voltage:
 - 1. Inspect the overall bus assembly and torque test primary bus bolted connections. Test insulation of each bus phase-to-phase and phase-to-ground with a megohmmeter. Record values and correct deficiencies.
 - 2. Check and adjust main and auxiliary contacts. Test each pole of each breaker for conductivity with a micro-ohmmeter. Test insulation of each breaker phase-to-phase and phase-to-ground with a megohmmeter. Record values and report deficiencies.

3. Check and adjust all breaker trips to settings required by the plans and verify settings versus manufacturer's curves by passing controlled current through the trip devices.
 4. Change dash-pot oil.
 5. Inspect arc chutes and replace if damaged.
- B. Oil Circuit Breaker, 5 K V.
1. Remove oil from tank and thoroughly clean tank, tank liner, lift rod, and terminal bushings. Flush tank with insulating oil and fill to proper level with new approved oil in accordance with manufacturer's instructions.
 2. Inspect all contacts for alignment and clean condition. Correct deficiencies as necessary.
 3. Inspect and tighten clamping nuts around bushings on top of breaker.
 4. Inspect breaker electric operating mechanism and correct deficiencies.
- C. Panelboards: Inspect the overall bus assemblies and tighten all loose bolted connections.

END OF SECTION

SECTION 16403

EMERGENCY SERVICE (GENERATOR)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall provide the equipment specified herein to provide for a new emergency electric service.

1.02 RELATED WORK

- A. Section 16021 - Concrete Work - Electrical
- B. Section 16024 - Trenching, Backfilling and Compacting - Electrical.
- C. Section 16050 - Basic Materials and Methods.
- D. Section 16155 - Motor Starter and Controls.
- E. Section 16400 - Service and Distribution.
- F. Section 15960 - Automation.
- G. Division - 14 - Elevators.

1.03 WORK BY OTHERS

- A. The following shall be provided under DIVISION 15, Mechanical.
 - 1. Main Fuel oil tank.
 - 2. Fuel oil piping from main tank to day tank.
 - 3. Necessary filler and vent piping and level gauge for main tank.
 - 4. Wiring for remote monitoring indications.
 - 5. Exhaust piping and installation of muffler.

1.04 SUBMITTALS.

- A. Furnish to the Architect shop drawings on the emergency generator and all related equipment. Included shall be the installation drawings called for in Section 3.01, A.

1.05 MANUFACTURERS

- A. The engine, generator and all major items of auxiliary equipment shall be products of U.S. manufacturers regularly engaged in the production of such equipment and shall be

assembled, tested and shipped to the job site by the engine manufacturer or his authorized distributor maintaining a parts and service facility in the area.

- 1. Standards:
 - a. Caterpillar

- b. Cummins.
- c. Generac.

1.06 WARRANTY

- A. Equipment furnished under this section shall be guaranteed against defective parts of workmanship for a period of 12 months form date of field testing and acceptance by the Owner.

1.07 START-UP, INSTRUCTIONS AND TEST #1

- A. The electric set shall receive the manufacturer's standard testing. Prior to approval of Test #1, the equipment shall be tested as described below. Correct any defects which become evident during testing.
- B. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the generator set supplier. Date for test start-up and instruction shall be at the convenience of the Owner and shall be arranged through the Architect and shall be witnessed by the Owner's representative and the Architect's field representative.
- C. Testing shall be done using a portable load bank as follows:
 - 1. Load Bank
 - a. 1/4 load - 30 minutes
 - b. 1/2 load - 30 minutes
 - c. 3/4 load - 30 minutes
 - d. Full load - 60 minutes
 - e. No load with full load switched "on" instantaneously
 - 2. Building Load.
 - a. Actual power failure condition shall be simulated with the entire expected building emergency system load turned on.
 - b. If an in-phase monitor is specified on the equipment branch, an oscilloscope or other proven means shall be used to demonstrate in-phase transfer of load.
- D. At the time of start-up, operating instructions and maintenance procedures shall be thoroughly explained to operating personnel. Two copies of operating and maintenance instruction books shall be supplied for the electric set and such auxiliary equipment as may require same.
- E. System shall be test at full KVA load at factory.

1.08 TEST #2

- A. Test #2 shall not be scheduled on the same date as Test #1 unless it is approved by the Architect.
- B. Date for test shall be at the convenience of the Owner and shall be arranged through the Architect and shall be witnessed by the Owner's representative and the Electrical Designer or his representative.
- C. Prior to approval of Test #2, the equipment shall be tested to show it will start automatically, subjected

to full load test. Correct any defects, which become evident during testing.

- D. Perform the test using the expected building load as follows:
 - 1. Actual power failure condition shall be simulated with the entire expected building emergency system load turned on.
 - 2. If an in-phase monitor is specified on the equipment branch, an oscilloscope, or other proven means, shall be used to demonstrate in-phase transfer of load.
- E. The test shall be performed by a factory-trained representative of the engine supplier.

1.09 SEQUENCE OF OPERATION

- A. A drop in voltage in any phase of the normal power service to 70% or less shall, after a time delay of 1-3 seconds (adjustable), close a contact which will initiate cranking of the engine.
 - 1. The starting control circuits shall be so arranged that cranking will commence immediately after closing of the contact. Four cranking cycles of ten seconds "on" and ten seconds "off" shall be provided. If engine fails to start after the four cranking cycles, the starting controls shall be locked out and require manual resetting.
- B. When the engine starts and reaches 90% of rated voltage and frequency, the life safety and critical branches (transfer switches 'LS' & 'CB') shall immediately transfer to the emergency power source.
- C. After a ten second delay, the equipment system (transfer switch 'EQ') shall transfer to the emergency power source.
- D. Upon restoration of the normal power service to 90% rated voltage and frequency on all phases, all emergency system branches shall be retransferred to the normal source after a time delay of 5-25 minutes (adjustable).
- E. After retransfer to the normal source, the engine shall run for five minutes unloaded than automatically shut down and be ready for the next power failure. If the normal service should fail during this five minute overrun period, the loads shall transfer back to the emergency power source in the same sequence as in B and C.
- F. If the emergency power source should fail while carrying the load, the loads shall be retransferred to the normal source immediately upon restoration of the normal source to 90% rated voltage and frequency on all phases.
 - 1. Failure of the engine while running shall lock out the starting controls and require manual resetting.
- G. Operating the system test button shall simulate a normal source power failure and shall cause a normal sequence of operations and transfer of load.
- H. When the plant is being exercised, only the equipment branch circuit (switch EQ) shall transfer to the emergency source. In the event of an actual power failure during exercising, all other branches shall transfer immediately to the emergency source.

PART 2 - PRODUCTS

2.01 EMERGENCY SERVICE COMPONENTS

- A. Electric Set Characteristics.

1. Standard ratings:
 - a. Standby KW (see drawings)
 - b. Standby KVA (see drawings)
 - c. Voltage (see drawings)
 - d. Power Factor 0.8
 - e. Frequency 60 hertz
2. Ratings must be substantiated with manufacturer's standard published curves. Special ratings for a particular application are not acceptable. Ratings must reflect the new power available after deducting all engine-driven or motor-driven accessories.
3. Engine Speed.
 - a. Maximum operating speed shall be 1800 RPM.
 - b. Frequency regulation shall be isochronous from no load to full load.
4. A voltage regulator shall be provided by the generator manufacturer to match the characteristics of the generator. Voltage regulation shall be + or - 1% voltage. Voltage adjusting re'estat to provide +/-5%.

B. Engine.

1. The engine shall be a full compression ignition diesel, two or four stroke cycle, single-acting, solid injection, water cooled inline or V-type. It shall meet specifications when operating on a commercial grade of fuel such as No.2 diesel fuel. Diesel engines requiring a premium fuel, lube oil and intake air filters; lube oil cooler, fuel transfer pump and any attachments required for continued, dependable operation.
2. The unit shall be mounted on a structural steel subbase and shall be provided with suitable vibration isolators spring type.
3. Provide safety shut-offs and alarms for high water temperature, low oil pressure and overspeed conditions.
4. Engine shall include water cooled exhaust manifold.

C. Generator.

1. The generator shall be engine driven, single bearing, self-aligning with brushless excitation, revolving field and amortisseur winding. Generator shall be directly connected to the engine housing and driven through a flexible coupling. insulation shall be Class F, 85 degrees C. rise at 40 degrees C. ambient. Each generator shall be rated 480/277 volt, 3 phase, 4 wire, 60 Hertz operation at rated RPM. Voltage regulator shall be solid state design, providing no load to full load regulation within +/-0,5% at rated voltage during steady state conditions. Instantaneous voltage dip shall not be greater than 12% of the rated voltage upon application of full load, at rated power factor, to the generator. Recovery time shall not exceed 1 second for restoration of stable voltage within +/-2%, of rated load. The generator characteristics must be matched to the torque characteristics of the engine in such a manner that with full load connected to the generator terminals, the generator can utilize all the available engine power without lugging or stalling. Each generator can utilize all the

available engine power without lugging or stalling. Each generator shall be equipped with cross current compensation control, rotating exciter and transient suppressors for paralleling operation. The generator bearing must be electrically insulated from the generator indelibly to prevent potential damaging shaft currents.

D. Excitation Support System.

1. The excitation support system shall be a permanent magnet pilot exciter or solid state excitation support to assist field forcing when the generator output voltage drops below 95% of nominal system voltage (job site adjustable 70% to 100% dropout) to sustain 300% of generator current rating for 10 cycles. The excitation support system must be compatible with the voltage regulator and be job site replaceable.

2. Standards:

Basler Electric, Kato

E. Cooling System. - (Remote)

1. Provide a radiator for remote mounting of sufficient capacity to maintain safe operating temperature at an ambient room temperature of 110 degrees F. Provide engine jacket water heater sized properly for the geographical location of installation. Engine shall be equipped with thermostats and jacket water pump of sufficient capacity to overcome piping losses for the distances and heights shown on the drawings. Equip the radiator with a 3-phase, 60 hertz motor-driven fan with voltage same as generator voltage. Properly sized motor starter with overload protection will be provided as part of the motor control center (MCC). Provide initiating contacts in generator control panel arranged to close on engine start and open on engine stop. Equip radiator with core guard and fan guard. Provide annular corrugated stainless steel flexible connections with woven wire braid covering at engine and radiator. Flexible connection shall be type KSSPC as manufactured by Kerflex, Inc., or equal.

2. The radiator and engine cooling system shall be filled with a 50% solution of ethylene glycol and distilled water to prevent freezing.

3. Limited space requires this unit to be approximately 57"W x 64"H x 36"D.

4. Radiator to have a horizontal discharge.

E. Cooling System.

1. Provide an engine mounted radiator of sufficient capacity to maintain safe operating temperature at an ambient room temperature of 100 degrees F. Engine shall be equipped with water pump and jacket water heater (2500 watts) with thermostatic control. Equip radiator with core and fan guard. Provide annular corrugated stainless steel flexible connections with woven wire braid covering at engine and radiator. Flexible connection shall be type KSSPC as manufactured by Kerflex, Inc., or equal.

2. The radiator and engine cooling system shall be filled with a 50% solution of ethylene glycol and distilled water to prevent freezing.

F. Exhaust System

1. Provide a critical type silencer, or equivalent, for remote mounting, properly sized according to the silencer manufacturer's recommendation for the engine used. A flexible exhaust fitting shall be provided for mounting between the engine exhaust and the exhaust pipe. The silencing system shall be of a type and size to insure against loss of engine power due to excessive backpressure.

G. Automatic Starting System.

1. Furnish a DC electric starting system with drive. The motor voltage shall be as recommended by the engine manufacturer.
2. Provide fully automatic engine start-stop controls in the generator control panel. Controls shall provide for overcrank lockout; pilot lights for low oil pressure, high water temperature, overspeed and overcrank; a four position selector switch marked "auto", "manual", "off", and "reset"; battery charger disconnect contacts; one auxiliary contact normally closed.
3. Provide a lead-acid storage battery set of the heavy duty diesel starting type. Battery voltage shall be compatible with the starting system. Battery shall be of sufficient capacity to provide for five consecutive full starts without recharging but in no case less than 220 AH. Supply a battery rack and all necessary cables.
4. Provide a battery charger that shall automatically hold the battery voltage at approximately 2.33 volts per cell on fully charged unloaded batteries. The charger shall be equipped with full charge unloaded batteries. The charger shall be equipped with full wave rectifiers, automatic surge suppressor, D.C. ammeter, D.C. circuit breaker, A.C. fuse. Input voltage shall be the same as generator output voltage.

H. Generator Control Panel.

1. Provide a generator control panel incorporating complete controls for all functions of the electric set and associated mechanisms. The panel shall be for generator mounting, MENA 1 type, of 14 gauge steel, dead front.
2. Panel shall contain, but not be limited to, the following equipment.
 - a. Voltmeter, 3-1/2 inch, 2% accuracy.
 - b. Ammeter, 3-1/2 inch, 2% accuracy.
 - c. Combination phase selector switch.
 - d. Frequency meter, vibrating reed.
 - e. Main line circuit breaker - sized for generator capacity.
 - f. Automatic starting controls as required by sequence of operation.
 - g. Automatic voltage regulator.
 - h. Auxiliary contacts as required to provide indications in the generator status panel at the (continuously manned station) (PBX station).

I. Fuel Oil Day Tank.

1. Sixty-gallon, free standing unit complete with 120 volt pump, necessary level controls vent to atmosphere and main shut-off solenoid valve.
2. Normal and emergency voltage as shown on drawings.
3. Switches LS & CB shall be wall mounted units in NEMA 1 enclosures.
4. Switch EQ shall be installed in the motor control center (MOCC).
5. The following accessories shall be furnished in the switches for control of the new emergency generator.

- a. Engine starting contact - 70% voltage.
 - b. Time Delay - 1-3 seconds to start cranking.
 - c. Time Delay - 5 to 25 minutes on retransfer with five minutes unloaded running time.
 - d. Test switch.
 - e. Auxiliary contacts - as required to provide desired operation.
 - f. Pilot lights indicating which mode the switch is in.
 - g. Overlapping neutral for coordination with GFI protection.
6. Switch EQ shall also contain the following:
- a. In-phase monitor so that retransfer from emergency-to-normal power, or from normal-to-emergency power shall not trip feeder breakers due to a high inrush caused by an out-of-phase transfer.
 - b. Ten second time delay on transfer to emergency.
 - c. System test switch which will simulate an actual power failure and cause the system to operate as if a power failure has occurred.
 - d. Ammeter and voltmeter and selector switches to indicate emergency system voltage and EQ current.
 - e. Auxiliary contact on emergency mode to interlock with the motor control center to lock out loads not required to run on emergency power.
7. See Drawings for ampere ratings.
8. Standards:
- Asco, Russell, Onan or Zenith.

K. Circuit Breakers.

1. Provide individual wall or panel mounted circuit breaker rated for full capacity of the generator set.

2.02 SPECIAL REQUIREMENTS

- A. The engine-generator, starting controls, batteries, charger and day tank will be installed in an unheated room and the equipment, while somewhat protected will be indirectly exposed to the weather. All the above equipment shall have the proper protection from the weather and the engine shall have the necessary heater to assure proper starting in cold weather.
- B. Radiator will be directly exposed to the weather. It shall be completely weatherproof.

2.03 ENCLOSURE (WEATHERPROOF BUILDING)

- A. All components of the emergency system except transfer switches, shall be installed in a prefabricated weatherproof building all the components prewired and prepiped.
- B. Enclosure shall be 25' long x 8' wide x 9.5' high with a 6' x 7' service door. Floor, roof and sides shall be made of fiberglass reinforced plastic bonded to a DFPA laminate core with a total wall thickness of 7/8".

Material shall have high impact resistant and not subject to corrosion or have high impact resistance and not subject to corrosion or electrolysis. All hardware to be rust resistant.

- C. Air intake and exhaust plenums shall have self-acting louvers to permit vertical ventilation. Cooling shall be unhampered by wind velocity or direction.
- D. Exterior finish shall be white "URA-GLASS" overlay, interior finish to be smooth flat white.
- E. Base shall be heavy duty structural steel with welded structural cross members.
- F. Provide 5kw, 208 volt, single phase heater with thermostat control for heating the enclosure.
- G. Provide 120 volt fluorescent lighting in housing and 2-duplex receptacles for general power use.
- H. Provide 3 phase, 4 wire electric panel in housing for wiring lights, receptacles, battery charger, heaters, etc. Panel shall have a circuit breaker for each device plus 2-1P20A spares.
- I. Provide a 2-lamp emergency battery unit mounted inside the housing to provide illumination if the power fails and the generator does not start. Unit shall utilize sealed lead calcium batteries and have an automatic 2-rate charger.

1. Standard:

Lightalarms 2PL3.

- J. Unit shall be delivered to the job site needing only main fuel supply and feeder connections to load side of generator circuit breaker to make emergency system operative.

K. Specified Standard:

Energy Systems, Inc., EPv-600

- a. 12 gauge insulated metal panel housing of similar design is also acceptable Exterior finish gloss white, interior finish flat white.

Standard:

Electrical Equipment, Inc. - Birmingham, Alabama

- L. Provide a 6" reinforced concrete pad and stoop for this unit to set on. Use #6 gauge welded wire mesh 6" x 6" pattern. Pad length and width to be 24 inches larger than house.

2.04 MAIN FUEL OIL TANK

- A. Provide as detailed on the drawings one heavy gauge underground oil storage tank, 4,000 gallons, approximately 7 foot diameter.
- B. Tank shall bear the U.L. label for underground service and shall meet the requirements of the Indiana State Fire Marshall as well as all applicable codes.
- C. Provide a concrete pad, tie down straps and backfill according to tank manufacturer's recommendations. Tanks shall be Kennedy or approved equal by Gemco Modern Welding Co., or Steel Tank and Fabricating Corporation.
- D. Provide a 24-inch manhole and all necessary fill and vent lines as per manufacturer's recommendations and the details on the drawings.
- E. Tank shall be coated by the manufacturer with one heavy coat of high quality black asphaltum. Any

damage to this coating in shipping or installation shall be patched by this trade prior to backfilling.

F. Fuel oil system appurtenances shall consist of, but not be limited to, the following:

1. Settle proof fill box with locking cap - Morrison Brothers #357-B.
2. Vent Cap - Morrison Brothers #155.
3. Supply & Return Piping - Type "L" soft copper.
4. Manhole - 24" diameter.
5. Gauges and Sensors - Simmons "Senior Model" or Pneumercator Co., Model "H-29".
6. Manhole Cover - similar to South Bend Foundry #MHS-550-70.
7. Locking cover on dipstick opening - Morrison Brothers #179.
8. Calibrated wood gauging rod.
9. Fill and vent piping - asphaltum coated black iron.

G. New underground oil lines shall be run in asbestos pipe and shall have dielectric unions in the manhole at the tank connections and immediately inside the building.

2.05 REMOTE INDICATIONS AT CONTINUOUSLY MANNED LOCATION (PBX)

A. Provide a flush mounted Generator Status Panel containing the following:

1. Visual only signal to indicate:
 - a. Emergency generator is running.
 - b. Battery charger malfunction.
2. Audible and visual signals to indicate:
 - a. Low oil pressure.
 - b. Low water temperature (below 70 deg. F).
 - c. High water temperature.
 - d. Failure to start (overcrank).
 - e. Overspeed.
 - f. Low fuel (less than 3 hours running time in the main tank).
3. Audible alarm silence switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. WARNING: Plant, all controls, and accessories shall be installed according to instructions of manufacturer who shall furnish complete installation layout drawing. The drawings shall be for this

Design-Aire Engineering, Inc.

specific installation and shall not be one of a typical or general nature.

- B. Final connections of all systems (wiring, piping, etc.) shall be the responsibility of the Contractor and shall be made under the supervision of the equipment manufacturer.
 - 1. Provide necessary interlock wiring from switch 'EQ' to the elevator controls.
 - 2. Provide necessary wiring from generator to remote generator status panel at continuously manned station.
 - 3. Provide necessary interlock wiring from switch 'EQ' to the motor control center.
- C. Main Oil Storage Tank.
 - 1. Shall be installed as detailed on the plan and in accordance with manufacturer's instructions.
 - 2. After installation, this trade shall temporarily cap vents and test tank and oil piping to the pumps with 5# air for a period of 24 hours to determine the presence of leaks prior to backfilling. The tank must be filled by this trade prior to starting the test.
 - 3. The tank shall be installed in good bedding and ground support practices as defined by the tank installation section of NFPA 31 with the exception that sand or pea gravel is recommended for backfill material. Provide a concrete pad and tie down straps according to the tank manufacturer's recommendations.

3.02a PIPING

- A. Provide fuel oil piping from main tank to the day tank. Copper will not be allowed. This piping shall be sized as required by the engine manufacturer and shall include the following:
 - 1. Supply and return fuel oil lines from the day tank to the main tank.
 - 2. Vent line from main tank - asphaltum coated black iron.
 - 3. Main tank filler piping - asphaltum coated black iron.
 - 4. Valves for proper functioning.
- B. Oil Line Piping.
 - 1. Oil line piping shall be subjected to a test of 5# air pressure for 24 hours.

3.02b PIPING

- A. Provide all piping except for main fuel line from main tank to the day tank. Copper will not be allowed. This piping shall be sized as required by the engine manufacturer and shall include the following:
 - 1. Supply and return fuel oil lines from engine to the day tank.
 - 2. Water lines from radiator to engine.
 - 3. Vent line from day tank.
 - 4. Exhaust piping.
 - 5. Valves for proper functioning.

3.03 INSTALLATION OF PIPING

- A. The full length of each section of underground piping shall rest solidly on the pipe bed. Piping connections to equipment shall be in accordance with the details indicated. The interior of the pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. The pipe shall not be laid in water or when the trench or weather conditions are unsuitable for such work, except by permission of the Architect. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth, or other substances can enter the pipe or fittings.
- B. Underground pipelines shall be laid with a minimum pitch of 1" per 25 feet. Valved drain connections shall be provided at low points, and valved and capped vent connections shall be provided at high points. Where the piping is to be anchored, the pipe shall be patched with protective covering as specified herein.
- C. Piping passing through concrete or masonry construction shall be fitted with sleeves as indicated.

3.04 TESTING PIPING

- A. Piping to be installed underground shall not receive field applied protective covering or be covered by backfill until the piping has successfully passed the pneumatic test for leaks described herein. Piping specified herein shall be tested under a pneumatic pressure of 90 lbs. per square inch for at least two hours during which time there shall be no drop in pressure in the line, allowances being made for thermal expansion and contraction. To facilitate this test, the Contractor may isolate various sections of the piping system and test each one separately. The Contractor shall furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection for the piping from the air compressor. No taps in the line will be permitted. The Contractor shall furnish necessary equipment for testing, and gauges shall be subject to testing and approval. In the event leaks are detected, the line shall be repaired and the test repeated. Upon completion of satisfactory tests, the pressure shall be relieved and the line immediately sealed. Suitable provision shall be made to prevent displacement of the piping during testing. Equipment such as pumps and meters shall be isolated from the piping system during this test.

3.05 PROTECTIVE COVERING

- A. After piping has passed the pneumatic pressure testing tightness, the exterior surface of the piping shall be thoroughly cleaned of foreign matter by wire brushing and solvent cleaning. The pipe shall be primed and immediately wrapped with corrosion resistant tape applied with a 50% overlap. Tape shall be hand-wrapped, hot-applied preformed coal tar tape.

3.06 CLEANING AND TESTING

- A. The fuel oil system shall be flushed with the same type of fuel intended for final use in the system, until the fuel being delivered is "clean". Clean means the absence of any sediment or emulsion. After various components of the system have been properly adjusted by the Contractor, the Contractor shall demonstrate to the satisfaction of the Architect that the system meets the performance requirements for which it was designed. In the event any portion of the system or any piece of equipment fails to meet the various tests, the Contractor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is obtained. All tests shall be witness by a representative of the Architect, and the Contractor shall notify the Architect sufficiently in advance of the test to permit arrangements for the use of government furnished items. All other instruments and equipment required to properly conduct the tests shall be furnished by the Contractor.

3.07 TRENCHING, BACKFILLING AND COMPACTING

- A. See Section 16024.

END OF SECTION

SECTION 16450

GROUNDING SYSTEM

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 16050 - Basic Materials and Methods
- B. Section 16142 - Electrical Connections for Equipment.
- C. Section 16143 - Wiring Devices
- D. Section 16155 - Motor Starters & Controls
- E. Section 16170 - Circuit & Motor Disconnects
- F. Section 16400 - Service and Distribution
- G. Section 16460 - Transformers
- H. Section 16470 - Electrical Panelboards.

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS

- A. Grounding conductors shall be copper bare or insulated in accordance with NEC.
- B. #4 AWG THW bare ground copper shall be provided by the electrical contractor for telephone equipment.

PART 3 - EXECUTION

3.01 EQUIPMENT GROUNDING METHODS

- A. Equipment shall be grounded through one of the following paths to ground.
 - 1. Conduit system.
 - 2. Separate grounding conductor installed in the conduit with the circuit conductors.
- B. Water lines throughout the building shall not be used for grounding purposes.
- C. At all electric service and motor control center install grounding bushings on all metal conduits and a lug on the panel backbox and bond conduits and backbox together using a bare copper conductor sized in accordance with NEC. Junction boxes in feeders conduit runs shall be bonded in a similar manner.
- D. At motor locations the motor frames shall be bonded to the ground system by means of a separate conductor pulled from the panel ground lug or a bonding jumper from the conduit to the motor frame.
- E. Service Entrance shall be tied to water service.

END OF SECTION

SECTION 16470
ELECTRICAL PANELBOARD

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division-16 Basic Materials and Methods section apply to work specified in this section.

1.02 - DESCRIPTION OF WORK

- A. Extent of panel board, load-center and enclosure work, including cabinets and cutout boxes are indicated by drawings and schedules.
- B. Types of panel boards and enclosures in this section include the following:
 - 1. Power-distribution panel boards.
 - 2. Lighting and appliance panel boards.
- C. This section does not specify switchboards, switchgear or similar types of electrical power distribution equipment. Refer to other Division 16 Sections.
- D. Refer to other Division 16 section for cable/wire, connectors and electrical raceway work required in conjunction with panel boards and enclosures; not work of this section.

1.03 - QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of panel boards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panel boards similar to those required for this project.
- C. NEC Compliance: Comply with NEC as applicable to installation of panel boards, cabinets, and cutout boxes, including NEC Article 384. Comply with NEC requirements pertaining to installation of wiring and equipment in hazardous locations where applicable.
- D. UL Compliance: Comply with applicable requirements of Std No. 67, "Electric Panel boards", and Std No.'s 50, 869, 486A, and 1053 pertaining to panel boards, accessories and enclosures. Provide units, which are UL-listed and labeled.
- E. Special Use-Markings: Provide panel boards, constructed for special-use, with appropriate UL marks which indicate that special type of use/application, such as when panel boards and enclosures are suitable for use as service-entrance equipment or for outdoor use.

- F. NEMA Compliance: Comply with NEMA Stds. Pub/No, 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)", Pub/No. PB 1, "Panel boards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panel boards Rated 600 Volts or less." Comply with NEMA Pub/No. PB 1.2, "Application Guide for Ground-fault Protective Devices for Equipment", where applicable.

1.04 - SUBMITTALS

- A. Product Data: Submit manufacturer's data on panel boards.
- B. Wiring Diagrams: Submit wiring diagrams for panel boards showing connections to electrical power feeders and distribution branches.

PART 2 - PRODUCTS

2.01 - ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering electrical panel board products which may be incorporated in the work include, but are not limited to, the following:
1. General Electric Company
 2. ITE/Siemens.
 3. Square D Company.
 4. Westinghouse Electric Corp.

2.02 - PANELBOARDS

- A. General: Except as otherwise indicated, provide panel boards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panel board devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated. Refer also to panel board schedules.
- B. Power Distribution Panel boards: Provide dead-front safety type power distribution panel boards as indicated, with panel board switching and protective devices in quantities, ratings, types and with arrangement shown; with anti-burn solderless pressure (compression) type main lug connectors approved for copper conductors. Select unit with feeder connecting at top of panel. Equip with copper bus bars, with not less than 98% conductivity, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case main and branch circuit breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panel boards with bare un-insulated grounding bar suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panel boards, which mate properly with panel boards.

- C. Lighting and Appliance Panel boards: Provide dead-front safety type lighting and appliance panel boards as indicated, with switching and protective devices in quantities, ratings, types and arrangement shown; with anti-burn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit-breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare un-insulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panel boards, which mate properly with panel boards.
- D. Panel board Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with "door in door" hinged cover and with flush locks and keys, all panel board enclosures keyed alike. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed or surface mounting, as applicable. Provide enclosures, which are fabricated by same manufacturer as panel boards, which mate properly with panel boards to be enclosed.
- E. Panel board Accessories: Provide panel board accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit breakers, ground-fault protection units, etc. as recommended by panel board manufacturer for ratings and applications indicated.

PART 3 - EXECUTION

3.01 - INSPECTION

- A. Installer must examine areas and conditions under which panel boards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 - INSTALLATION OF PANELBOARDS

- A. General: Install panel boards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of panel boards and enclosures with cable and raceway installation work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A. Where manufacturer's torque requirements are more stringent, manufacturer's requirements shall be followed.
- D. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- E. Provide properly wired electrical connection within enclosures when connections are included in work of this section.
- F. Fill out panel board's circuit directory card upon completion of installation work. Directory cards shall be typed.

3.03 - GROUNDING

- A. Provide equipment grounding connection for panel boards as indicated. Tighten connections to comply with tightening torques specified in UL Stds 486A to assure permanent and effective grounds.

3.04 - FIELD QUALITY CONTROL

- A. Prior to energizing of circuitry, check all accessible connection to manufacturer's tightening torque specifications.
- B. Prior to energizing panel boards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energizing, check panel boards for electrical continuity of circuits, and for short-circuits.
- D. Subsequent to wire and cable hook-ups, energize panel boards and demonstrate functioning in accordance with requirements. Where necessary, correct mal-functioning units, and then retest to demonstrate compliance.

END OF SECTION 16470

SECTION 16500

INTERIOR BUILDING LIGHTING

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 16 Basic Material and Methods sections apply to work specified in this section.

1.02 - DESCRIPTION OF WORK

- A. Extent of interior lighting fixture work is indicated by drawings and schedules.
- B. Types of interior lighting fixtures in this section include the following:
 - 1. Fluorescent.
 - 2. Incandescent.
 - 3. High Intensity Discharge
 - 4. Quartz
- C. Applications of interior lighting fixtures required for project include the following:
 - 1. General lighting.
 - 2. Supplementary lighting.
 - 3. Emergency lighting.
 - 4. Task lighting.

1.03 - QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of interior lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with interior lighting fixture work similar to that required for project.
- C. NEC Compliance: Comply with NEC as applicable to installation and construction of interior building lighting fixtures.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Std. Pub. Nos. LE 1 and LE 2

pertaining to lighting equipment.

- E. ANSI/IES Compliance: Comply with ANSI 132.1 pertaining to interior lighting fixtures.
- F. ANSI/UL Compliance: Comply with ANSI/UL standards pertaining to interior lighting fixtures for hazardous locations.
- G. UL Compliance: Provide interior lighting fixtures which have been UL-listed and labeled. Fixtures shall comply with UL 57, 676, 1570, 1571, and 1572 where applicable.
- H. CBM Label: Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.04 - SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior building lighting fixtures.
- B. Shop Drawings: Submit dimensioned drawings of interior lighting fixture installations, including but not necessarily limited to, layout, relation to associated panelboards, and connections to panelboards. Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet.

PART 2 - PRODUCTS

2.01 - ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed on fixture schedule.
- B. Alternate Manufacturers: Identification by means of manufacturers' names and catalog numbers is to establish basic features and performance standards. Any substitutions must meet or exceed THESE standards.
- C. Qualifications: Within 60 days of placement of order, Contractor must furnish independent photometric tests and samples (if requested) for all alternative fixtures. If fixture fails to comply with specification requirements at that time, Contractor will furnish acceptable fixture at no additional cost to the Owner, and with no delay to project.

2.02 - INTERIOR LIGHTING FIXTURES

- A. General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not necessarily limited to housing, lamps, lamp holders, reflectors, ballasts, starters and wiring.
- B. Fluorescent-Lamp Ballasts: Provide fluorescent-lamp ballasts, capable of operating lamp types indicated; with high power factor 90% or greater, rapid-start, and low-noise features; Type 1; Class P; sound-rated A, and with internal thermal protection, and complying with UL 935 and Ans C82.1. These ballasts shall not be applied in fluorescent lamp dimming systems.
- C. Comply with any additional fixture requirements contained in any Interior Lighting Fixture Schedule at end of this section or shown on drawings.

- D. Lamps: Shall be T-8, 32 watts with color spectrum at 35K or as specified on the Light Fixture Schedule.
- E. Radio interference suppressors: Coordinated and compatible with respective ballast, included where indicated.
- F. High Power Factor Ballast: Provide HID lamp ballast of ratings, types and makes as recommended by lamp manufacturer, which properly matches lamps to power line by providing appropriate voltages and impedance's for which lamps are designed. Ballasts shall comply with UL 1029.

PART 3 - EXECUTION

3.01 - INSTALLATION OF INTERIOR LIGHTING FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instruction, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures.
- C. Fasten fixtures securely to indicated structural support; and check to ensure that solid pendant fixtures are plumb.

3.02 - ADJUST AND CLEAN

- A. Clean interior lighting fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during remainder of construction period.

3.03 - FIELD QUALITY CONTROL

- A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing
- B. At the time of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect/Engineer. Furnish stock or replacement lamps amounting to 15% (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space.
- C. Refer to Division 1 sections for the replacement/restoration of lamps in interior lighting fixtures, where used for temporary lighting prior to time of Substantial Completion.

3.03 - GROUNDING

- A. Provide tight equipment grounding connections for each interior lighting fixture installation where indicated.

END OF SECTION

SECTION 16510
EXTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Exterior luminaries and accessories.
- B. Lamps.
- C. Ballasts.
- D. Poles.

1.02 RELATED WORK

- A. Section 16110 - Raceways & Conduit.
- B. Section 16450 - Grounding
- C. Section 16536 - Time Clocks

1.03 REFERENCES

- A. ANSI C82.4 - Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type.)
- B. NEMA Le 2 - H-I-D Lighting System Noise Criterion (Ls-NC) Ratings.

1.04 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Include outline drawings, lamp and ballasts data, support points, weights, and accessory information for each luminaire type.
- C. Submit manufacturer's installation instructions under provisions of Section 01300.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
- B. Store and protect products under provision of Section 01600.
- C. Handle metal poles carefully to prevent breakage and damage to finish.

PART 2 - PRODUCTS

2.01 EXTERIOR LUMINAIRES AND ACCESSORIES

- A. Standard mounted 250 watt metal halide fixtures, 175 watt metal halide (ground mounted), 100 watt metal halide well light, and 70 watt building mounted Metal Halide Wallpack fixtures.
1. Enclosures: Complete with gaskets to form weatherproof assembly shall be made in two (2) sections for ease of maintenance; both upper (fixed) and lower (hinged) section shall be of sturdy, corrosion-resistant die-cast aluminum construction joined together by an integral cast hinge in upper section. Provided with a retaining device in upper section to prevent accidental disengagement of lower section.
 2. Provide positive latch mechanism (double or single) to hold lower section to upper section forming a fully tight-closed-position.
 3. Finish shall be either baked acrylic enamel or acrylic/enamel applied by electrostatic process.
 4. Power deck shall contain the ballast, capacitors, wiring terminals, and lamp holder assemble.
 5. Terminal block accept copper conductors up to No.6 AWG wire.
 6. Porcelan enclosed socket adjustable for the various light patterns of high-pressure sodium, or metal halide lamps:
 - a. Narrow Beam
 - b. Medium Beam
 - c. Wide Beam
 7. Internal wiring is high temperature irradiated polyethylene insulated 16 AWG fixture wire. All units shall be factory wire and external power shall be 120 volts AC.
 8. Refractor of prismatic design as specified by I.E.S. to produce a symmetric lighting pattern, Type II, III and IV with high intensity discharge lamps.
 - a. One piece molded lens material for maximum resistance of ninety (90) pounds P.S.I. impact and thermal shock.

Polycarbonate for up to 400 watt.

Borosilicate glass for up to 250 watts

Acrylic for up to 175 watt.
 9. Seals or filter gaskets shall be two-fold; allow air to circulate in and around optical assemble, but also to prohibit entrance of external contaminants. Weather resistant gasket material may be (Ethylene Propylene Terpolymers) or (E.P.T.) or heat and moisture-resistant rubber providing protection of reflector and refractor to insure maintained light output.

10. Reflector shall be constructed from corrosion-resistant material i.e. sheet aluminum finished with Alzak process or sheet aluminum finished with hard anodic surface. Supplied with a gasket to provide a seal between the reflector and the refractor.

B. Provide low temperature ballasts, with reliable starting to 0 (-20) °F (°C).

2.02 ACCEPTABLE MANUFACTURERS - LAMPS

- A. General Electric Co.
- B. Sylvania.
- C. Westinghouse/Norlco or approved equal.
- D. Substitutions: Under provisions of Section 01600.

2.03 LAMPS

A. Metal Halide HID Lamps: 400 watts, 70 watts.

2.04 HID BALLASTS

- A. HID Ballast: ANSI C82.4; suitable for 122 °F (50 ° E. Lexington Standard Corp.
- B. Guardian Light/Outdoor Lighting.
- C. Hapco
- D. ITT Outdoor Lighting Standard.
- E. Substitutions: Under provisions of Section 01600.

2.05 ACCEPTABLE MANUFACTURERS - POLES

- A. ASL - Area Lighting Standards
- B. Guardian Light/Outdoor lighting.
- C. Hapco
- D. ITT Outdoor lighting standard
- E. Lexington Standard Corp.
- F. Millerbernd
- G. P & K

2.06 LIGHTING POLES

- A. Metal Poles: Twenty Five (25) foot square straight aluminum lighting pole with anchor base.
- B. Wind Load: 90 mph velocity, with luminaires and brackets mounted.
- C. Hand Hole: 4 x 6 inches with removable weatherproof cover installed 18 inches above bottom of pole. Provide matching gasketed cover plate.
- D. Pole Top: slipfitter clamp fits 1 1/4 inch through 2 7/8 inch mast arms supports without requiring adapters or rearrangement of component parts.
 - 1. Vertical adjustment pad provided on top of the upper section allows + 3 vernier adjustment in slipfitter cradle to assure proper alignment with mast arm support. Clamping and level adjustment hardware may be either internal or external and shall be corrosion proof.
 - 2. Provide slipfitter bugshield to prevent entrance of insects or birds through slipfitter opening.
 - 3. Provide slipfitter channel support guide to prevent false stops, exert even pressure over the full five (5) inch channel/mast arm, and to eliminate points of high stress.
- E. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.
- F. Fabricate complete concrete standard base as shown on drawing.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lamps in lamp holders.
- B. HID Luminaires: Provide safety chain between reflector and ballast.
- C. Luminaire Pole Bases: Size and constructed as indicated on Drawings. Project anchor bolts 2 inches minimum above base. Install poles on bases plumb; provide shims and double nuts for adjustment. Grout around pole base.
- D. Embedded Luminaires: Concrete base to depth indicated on the drawing, below finished grade. Install plumb.
- E. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.02 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses at completion of Work.
- B. Touch up luminaire and pole finish at completion of work.

END OF SECTION

SECTION 16534

EMERGENCY LIGHTING EQUIPMENTS

PART 1 GENERAL

1.01 WORK RELATED

- A. Section 16500 - Interior Building Lighting.

1.02 REFERENCES

- A. FS W-L-305 - Light Set, General Emergency Illumination.
- B. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
- C. NEMA WD1 - General-Purpose Wiring Devices.

1.03 REGULATORY REQUIREMENTS

- A. Conform to NFPA 101 for installation requirements.

1.04 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Provide product data on emergency lighting units and exit signs.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - INCANDESCENT EMERGENCY LIGHTING UNITS

- A. See "Light Fixture Schedule" on drawings for approved manufacturers.

2.02 INCANDESCENT EMERGENCY LIGHTING UNITS

- A. Emergency Lighting Unit: FS W-L-305; Type I, Class I, Style D. Self-contained unit with rechargeable storage batteries, charger, and lamps.
- B. Battery: 6 volt, nickel-cadmium type, with 1.5 hour capacity to supply the connected lamp load. Minimum life expectancy of battery to be between five (5) to seven (7) years.
- C. Charger: Dual-rate charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 12 hours, at normal ambient temperature for 77 F.
- D. Lamps: Two (2) 12 Watt minimum, sealed beam type in nickel or chrome plated steel housing. Burning rate will be 87.5% or normal battery system's voltage at 6 volts.
- E. Unit Housing: 18 and 20 gauge steel with gray hammer tone finish designed to meet or exceed NEMA-4, NEMA-4x or NEMA-12: protected with acid resistant spray paint complying to FM method 6061, N0. 141

and Method 2011.1.

- F. Indicators: Provide lamps to indicate AC ON and RECHARGING.
- G. Provide "Press-To-Test" switch to transfer unit from normal supply to battery supply for battery check.
- H. Accessories: Fuse protection to both primary and secondary circuits; supplied with suitable wall mounting shelf and brackets.
- I. Electrical Connection: 3 foot (1 m) cord with NEMA WD 1, Type 5-15P cap.
- J. Unit Voltage: 120 volts, AC., 60 Hz, un-switched single phase source.

2.03 ACCEPTABLE MANUFACTURERS - SELF-CONTAINED EMERGENCY POWER EXIT SIGNS (LED)

- A. See "Light Fixture Schedule" on drawings for approved manufacturers.

2.04 SELF-CONTAINED EMERGENCY POWER EXIT SIGNS. (LED)

- A. Type Exit signs with integral battery-operated emergency power supply, including power failure relay, test switch, AC ON pilot light, battery, and fully-automatic two-rate charger.
- B. Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for 10 years under normal conditions.
- C. Surface mounted signs provided with opening in bottom of case to cast down light. Provide with universal mount to allow selection of back, top or end mounting position.
- D. Unit connected to an un-switched 120 volt, AC, 60 Hz, single-phase power source.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units plumb and level.
- B. Aim directional lamp heads as directed on the drawing.

END OF SECTION

SECTION 16710

DOOR SECURITY EMPTY CONDUIT SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide empty conduit for future door security system.
- B. Related Work Specified Elsewhere.
 - 1. Section 16050 - Basic Materials and Methods.
 - 2. Section 16110 - Raceways & Conduits

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Make installation as required by manufacturer or as indicated on drawings.

END OF SECTION

SECTION 16721

FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.01 - RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 16 Basic Materials and Methods sections apply to work specified in this section.

1.02 - DESCRIPTION OF WORK

- A. ~~Extent~~ of fire alarm and detection system work is indicated by drawings and schedules.
- B. ~~Types~~ of fire alarm and detection systems in this section shall be new.

1.03 - OPERATION

- A. Manual pull stations, smoke detectors, duct detectors, and horn/strobes, shall be fully supervised for placement, opens and grounds.
- B. Operation of manual stations and automatic detectors to function as follows without delay:
 - 1. Actuate control panel to cause evacuation alarm to sound non-coded signal throughout the building.
 - 2. Indicate alarm origin on panel.
 - 3. Air supply and return fans to shut down.
 - 4. Transmit signal to local authorities.
 - 5. System shall continue to sound until the activating device is restored to normal, the alarm is acknowledged, or the control panel is manually reset.
- C. In the event of an open or ground in the initiation or indicating circuits, the trouble will be indicated by the sounding of the trouble buzzer and illumination of the trouble light at the control panel. The trouble buzzer may be silenced by operation of the "Trouble Silence" switch, but the trouble light will remain illuminated until trouble is corrected.
- D. Trouble annunciation to be provided at the control panel.

1.04 - QUALITY ASSURANCE

- A. ~~Manufacturers~~: Firms regularly engaged in manufacture of fire alarm and detection systems, of types, sizes, and electrical characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. ~~Installer~~: Qualified with at least 5 years of successful installation experience on projects with fire alarm and detection system installation work similar to that required for project.
- C. ~~NEC Compliance~~: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.

- D. ~~UL Compliance and Labeling~~: Provide fire alarm and detection system components which are UL-listed and labeled.
- E. ~~FM Compliance~~: Provide fire alarm and detection systems and accessories which are FM-approved.
- F. ~~ADA Compliance~~: Provide Fire Alarm and detection systems and accessories at heights and in areas as specified by ADA.

1.05 - SUBMITTALS

- A. ~~Product Data~~: Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and wiring diagrams.
- B. ~~Shop Drawings~~: Provide shop drawings showing equipment/device locations and connecting wiring of entire fire alarm and detection system. Include wiring diagrams and riser diagrams.

1.06 - MANUFACTURERS

- A. Manufacturer shall be Siemens, Edwards, or Gamewell.

PART 2 - PRODUCTS

2.01 - FIRE ALARM AND DETECTION SYSTEMS

- A. ~~General~~: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation.

2.02 – MATERIALS AND EQUIPMENT

- A. ~~Wiring System Materials~~: Provide basic wiring material which comply with Division-16 Basic Materials and Methods sections, "Raceways", "Wires and Cables", and "Electrical Boxes and Fittings"; types to be selected by Installer.
- B. ~~Manual Fire Alarm Stations~~: Provide manufacturer's standard construction, red enclosure, manual fire alarm stations with the following features:
 - 1. The single action, non-coded manual station shall consist of a die-cast aluminum housing fitted with a pull lever which, when operated, locks in position after activating an alarm initiating contact. This lever shall protrude until reset. Resetting the station after operation shall require opening the front cover with an Allen key for access to the alarm switch installation.
- C. ~~Automatic Smoke (Combustion Products) Detectors~~: Provide manufacturer's standard construction automatic smoke detectors of the following types:

1. The scattered light smoke detector shall operate on the ionization principle. It shall comply with UL 268 specifications. The detector head shall be a plug-in unit and member of an interchangeable detector family of ionization, which may be modified from one style detector to another without having to rewire the system. The detector shall employ a forward light scattering principle and not contain any moving parts. Smoke entering the detector scatters the light across the receiver and produces a signal which is evaluated by a multiple pulse coincidence circuit. An alarm is sounded when the smoke concentration exceeds the designed threshold. The detector's sensitivity shall not be affected by the presence of ambient light, air currents, or voltage variations within the specified range of 16-30 VDC. The detector base shall have a LED for alarm and shall have the option for an auxiliary relay.
- D. ~~Automatic Duct Detector~~: Provide manufacturer's standard construction automatic duct detector of the following types:
1. The duct detector shall continually sample a cross-section of air flow in a duct and send an alarm whenever the quantity of smoke exceeds given limits. Upon activation, the smoke detector initiates an alarm signal, energizes a visual indicator and an alarm relay in the detector. The detector shall use a perforated metallic tube for sampling. The detector shall be a 4-wire type detector.
- E. ~~Combination Alarm Unit~~: Provide manufacturer's standard construction combination horn and strobe unit.
1. The Audible/Visual device shall be a combination Horn/Strobe specifically designed for life-safety use. The vibrating diaphragm mechanism is attached to a die-cast zinc grill and is red in color. The horn is polarized for supervision. The visual alarm device shall be a three dimensional, triangular warning light and shall be a xenon tube strobe device. The strobe shall have a white lens with red lettering. The devices are to be of the low current type.

PART 3 - EXECUTION

3.01 – INSTALLATION OF FIRE ALARM AND DETECTION SYSTEMS

- A. ~~Install~~ fire alarm and detection systems as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."
- B. Fire Alarm shall be installed in conduit unless plenum rated cable is used.

3.02 – INSTALLATION OF BASIC IDENTIFICATION

- A. ~~Install~~ electrical identification in accordance with Division 16 Basic Materials and Methods section "Electrical Identification."

3.03 – INSTALLATION OF BASIC WIRING SYSTEM MATERIALS

- A. ~~Install~~ wiring, raceways, and electrical boxes and fittings in accordance with Division 16 Basic Materials and Methods sections, "Raceways," "Wires and Cables," "wiring devices", and "Electrical Boxes and Fittings."

3.04 – FIELD QUALITY CONTROL

- A. ~~Inspect~~ relays and signals for malfunctioning and, where necessary, adjust units for proper operation

to fulfill project requirements.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of fire alarm and detection system equipment.

END OF SECTION