

**SECTION 15450**  
**PLUMBING EQUIPMENT**

**PART 1: GENERAL**

**1.1 WORK INCLUDED**

Water heaters.

**1.2 RELATED WORK**

- A. Section 15140 - Supports and Anchors.
- B. Section 15242 - Vibration Isolation.

**1.3 REFERENCES**

UL 174 - Household Storage Tank Water Heaters.

**1.4 QUALITY ASSURANCE**

Ensure products and installation of specified products is in conformance with recommendations and requirements of the following organizations:

- 1. Underwriters Laboratories (UL).

**1.5 REGULATORY REQUIREMENTS**

Conform to UL 174 requirements for water heaters.

**1.6 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Division 1.
- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. Submit manufacturer's installation instructions under provisions of Division 1.
- D. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.

**1.7 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include operation, maintenance and inspection data, replacement part numbers and availability and service depot location and telephone number.

**1.8 DELIVERY, STORAGE AND HANDLING**

- A. Deliver products to site.

- B. Store and protect products.
- C. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

#### 1.9 WARRANTY

- A. Provide three-year manufacturer's warranty.
- B. Warranty: Include coverage of commercial water heaters.

### **PART 2: GENERAL**

For Equipment Model Numbers see Schedule on Drawings.

#### 2.1 ACCEPTABLE MANUFACTURERS - WATER HEATERS

- A. A.O. Smith.
- B. Lochinvar.
- C. Rheem.

#### 2.2 WATER HEATERS

The equipment hereinafter described is to be furnished and installed complete by this Contractor. See "Equipment Schedule" on drawings for size, capacity and model.

Electric Water Heater: Water heater shall bear the UL label and shall have the manufacturer's name, serial number, capacity in gallons, kW input rating and date of installation firmly fastened thereto. The heater shall be complete, ASME approved pressure and temperature relief valve, snap acting automatic thermostat. Pipe relief drain to nearest approved floor sink or as indicated on drawings. For size and capacity see drawings.

### **PART 3: EXECUTION**

#### 3.1 WATER HEATER INSTALLATION

- A. Install water heaters in accordance with manufacturer's instructions and to UL requirements.
- B. Coordinate with plumbing piping and related electrical work to achieve operating system.

**"END OF SECTION"**

## SECTION 15535

### REFRIGERATION PIPING AND SPECIALTIES

#### PART 1: GENERAL

##### 1.1 SECTION INCLUDES

- A. Piping
- B. Refrigerant
- C. Moisture and liquid indicators.
- D. Valves
- E. Strainers
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers
- L. Flexible connections.
- M. Pressure regulator.

##### 1.2 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Submit shop drawings indicating schematic layout of system, including equipment, critical dimensions and sizes.
- C. Submit product data indicating general assembly of specialties, including manufacturers catalogue information.
- D. Submit manufacturer's installation instructions.
- E. Submit welder's certification of compliance with AWS D1.1 on systems using welded steel piping.
- F. Submit data indicating pipe sizing.
- G. Submit test reports.

- H. Submit Test reports indicating results of leak test, acid test.

### 1.3 PROJECT RECORD DOCUMENTS

- A. Submit record documents.
- B. Accurately record exact locations of equipment and refrigeration accessories on record drawings.

### 1.4 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site.
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Store and protect products.
- D. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

## PART 2: PRODUCTS

### 2.1 PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed for gage and control device connections.
  - 1. Fittings: ASME B16.22 wrought copper.
  - 2. Joints: ASTM B32, solder Grade 95TA.
- B. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.
  - 1. Fittings: ASME B16.26 wrought copper.
  - 2. Joints: Flared.
- C. Steel Pipe: ASTM A53, Schedule 40 and 0.365 inch wall for sizes 12 inch and over, black.
  - 1. Fittings: ASTM A234, forged steel welding type.
  - 2. Joints: AWS D1.1, welded.

### 2.2 REFRIGERANT

Refrigerant: See condensing unit schedule.

### 2.3 MOISTURE AND LIQUID INDICATORS

Indicators: Double port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator and plastic cap; for maximum working pressure of 460 psi and maximum temperature of 200 degrees F.

### 2.4 VALVES

- A. Diaphragm Packless Valves: UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends with positive back seating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves: Forged brass or nickel plated forged steel for steel piping, forged brass seal caps with copper gasket, rising stem and seat with back seating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Packed Ball Valves: Two piece forged brass Body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 325 degrees F.

### 2.5 STRAINERS

- A. Straight Line or Angle Line Type: Brass or steel shell, steel cap and flange, and replaceable cartridge with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.
- B. Straight Line, Non-Cleanable Type: Steel shell, copper plated fittings, stainless steel wire screen for maximum working pressure of 430 psi.

### 2.6 CHECK VALVES

- A. Globe Type: Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 450 psi and maximum temperature of 300 degrees F.
- B. Straight Thru Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 250 degrees F.

### 2.7 PRESSURE RELIEF VALVES

Straight Thru or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 450 psi setting; selected to ASHRAE 15.

### 2.8 FILTER-DRIERS

- A. Replaceable Cartridge Angle Type: ARI 750, UL listed, brass shell and bronze cap, perforated brass shell and molded desiccant filter core; for maximum working pressure of 350 psi.

- B. Permanent Straight Thru Type: ARI 750, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 400 psi.

## 2.9 SOLENOID VALVES

- A. Valve: ARI 760, pilot operated, copper or brass [or steel] body and internal parts, synthetic seat, stainless steel stem and plunger assembly with flared, solder or threaded ends; for maximum working pressure of 450 psi. Stem shall permit manual operation in case of coil failure.
- B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof with surge protector and color coded lead wires, integral junction box UL 429.

## 2.10 EXPANSION VALVES

- A. Angle or Straight Thru Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

## 2.11 RECEIVERS

- A. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psi, maximum pressure rating, with tapings for inlet outlet, and pressure relief valve.
- B. Internal Diameter Over 6 inch: ARI 495, welded steel, tested and stamped in accordance with Section 8D of the ASME Boiler and Pressure Vessels Code; 400 psi with tapings for inlet, outlet and pressure relief valve.

## 2.12 FLEXIBLE CONNECTORS

Corrugated [stainless steel] [bronze] hose with single layer of [stainless steel] exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 400 psi.

## 2.13 PRESSURE REGULATOR

For hot gas bypass, evaporator and crankcase pressure regulation. Body shall be bronze or forged steel with fully adjustable pressure setpoint, upstream or downstream selection depending on function. Connections to be sweat or flaired for copper tube connection or steel for welded connection to steel piping.

# PART 3: EXECUTION

## 3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.

- C. Prepare piping connections to equipment with flanges or unions.

### 3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Provide non-conducting dielectric connections when joining dissimilar metals.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access to concealed valves and fittings. Coordinate size and location of access doors with related architectural sections.
- I. Where pipe support members are welded to structural building frame, brush clean and apply one coat of zinc rich primer to welding.
- J. Prepare pipe, fittings, supports and accessories not prefinished, ready for finish painting. Refer to Section 09900.
- K. Insulate piping; refer to Section 15260.
- L. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line on a horizontal line with the bulb located between 9:00 and 12:00 o'clock.
- M. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- N. Install flexible connectors at right angles to axial movement of compressor.
- O. Fully charge completed system with refrigerant after testing.
- P. Provide electrical connection to solenoid valves. Refer to Section 16180.

### 3.3 APPLICATION

- A. Provide line size liquid indicators in main liquid line leaving condenser, or if receiver is provided in liquid line leaving receiver.
- B. Provide line size strainer upstream of each automatic valve. Where multiple expansion valves with integral strainers are used install single main liquid line strainer.
- C. On steel piping systems, provide strainer in suction line.

- D. Provide shut-off valve on each side of strainer.
- E. Provide permanent filter-driers in low temperature systems and systems utilizing hermetic compressors.
- F. Provide replaceable cartridge filter-driers, with three-valve bypass assembly on all open drive or semi-hermetic compression.
- G. Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down and in hot gas bypass lines to accomplish pump-down.
- H. Provide refrigerant charging packed angle valve connections in liquid line between receiver shut-off valve and expansion valve.
- I. Utilize flexible connectors at or near compressors where within piping configuration does not absorb vibration.
- J. Use only copper tubing which has been stored with caps in place. Open piping must be capped at end of each work shift.
- K. Brazing of copper lines shall be done only when a small flow of dry nitrogen is passing through the tube to prevent formation of copper oxide.
- L. After leak testing triple evacuate system to 500 microns breaking vacuum, with type of refrigerant that will be used in system between evacuations.

#### 3.4 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using halide torch electronic leak detector or with fluorescent dye and ultra violet light. Test to no leakage.

**"END OF SECTION"**



## SECTION 15774

### SPLIT TYPE HEAT PUMPS

#### PART 1: GENERAL

##### 1.1 QUALITY ASSURANCE

Requirements of Regulatory Agencies: Each unit shall be UL labeled.

##### 1.2 WARRANTY

Five year warranty on compressors, warranty certificate with expiration date shall be given to Owner after equipment start-up.

#### PART 2: PRODUCTS

##### 2.1 MANUFACTURED UNITS

Split System Heat Pumps: Units shall be air-cooled heat pump/direct expansion fan coil combinations. The heat pump outdoor section shall be factory assembled having direct-drive fans with horizontal or vertical air discharge, reciprocating compressor, refrigerant coil, fan motor(s), prewired control panel and a holding charge of refrigerant R-410. The indoor fan coil unit shall have horizontal discharge and will include refrigerant coil, fan and motor, condensate pan with drain, thermal expansion valve, prewired control panel and remote control as shown on drawings.

1. Actual unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on the drawings.
2. Refrigerant coils shall be of copper construction with mechanically bonded, smooth aluminum plate fins. All tube joints shall be brazed with phoscopper or silver alloy. Coils shall be pressure tested at the factory.
3. Condenser Fan and Motors: Condenser fan shall be direct driven, propeller type arranged for horizontal or vertical discharge. Condenser fan motors shall have inherent protection, and shall be of the permanently lubricated type, resiliently mounted for quiet operation. Each fan shall have a safety guard.
4. Evaporator fan section shall have forward-curved blades, double inlet fans mounted on a solid shaft. Fan shall be statically and dynamically balanced and shall run on permanently lubricated bearings.
5. Cabinets shall be made of galvanized steel, bonderized and finished with baked enamel.
6. Compressor shall be serviceable semi-hermetic/hermetic type. It shall be mounted so as to avoid vibration; it shall be equipped with high and low-pressure protection. Provide 5-minute compressor recycle protection.
7. System Control: The system shall utilize a microprocessor controller with diagnostic capability, located in the indoor unit. Wall mounted control with

operation indicator to be used for temperature control, heating, cooling mode selection, on/off switching.

8. Return air shall be filtered by means of easily removable replaceable filters. The filters shall be accessible without tools or exposure to hazardous electrical or moving parts. Provision shall be made to have a filtered outdoor air duct connection to provide fresh air to the unit.
9. Manufacturer: Carrier, York or Trane.

### **PART 3: EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

Manufacturer's Field Service:

1. Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
  - a. Mechanic shall use checkout sheet provided by manufacturer, complete and sign all items on sheet and submit to Architect.

#### **3.2 INSTALLATION**

- A. Install equipment as shown on the drawings and in compliance with the manufacturer's recommendations, complete with vibration isolation, mounting pads or foundations, and flexible connectors, refrigerant piping and piping accessories as required.
- B. Inspect the areas under which work of this section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

#### **3.3 EQUIPMENT FOUNDATIONS**

- A. Equipment foundations, where indicated, shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under any abnormal conditions, which could be imposed upon the equipment. Foundations shall meet the requirements of the equipment manufacturer, and when required by the Architect, the Contractor shall obtain from the equipment manufacturer approval of the foundation design and construction for the equipment involved. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated.

#### **3.4 EQUIPMENT DESIGN AND INSTALLATION**

- A. Uniformity: Unless otherwise specified, equipment of same type or classification shall be the product of the same manufacturer.
- B. Application: No piece of equipment shall be installed in an application not recommended by the manufacturer.
- C. Equipment Installation: Equipment installation shall be strictly in accordance with these specifications, and the installation instructions of the manufacturers. Equipment mounted on concrete foundations shall be grouted before piping is installed. All piping shall be installed in such a manner as not to place a strain on any of the equipment. Flanged

joints shall be adequately extended before installation. All piping shall be graded, anchored, guided and supported, without low pockets.

1. Erect equipment in a neat and workmanlike manner, properly aligned, leveled and adjusted for satisfactory operation.
2. Install so that connecting and disconnecting of piping and accessories can readily be done, and so that all parts are readily accessible for inspection, service and repair.

### 3.5 NOISE AND VIBRATION

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate with dampening noise and vibration to design level or less.
- B. Corrective Measures: If such objectionable noise and vibration should be produced, make necessary changes to produce satisfactory results.

### 3.6 FIELD TESTS AND INSPECTION

- A. General: Perform all field investigations, field tests, and trial operations as specified in Section 15010. Provide all labor, equipment and incidentals required for the testing.
- B. Equipment and Material: Equipment and material certified as having been successfully tested by the manufacturer in accordance with referenced specifications and standards will not require retesting before installation. Equipment and materials not tested at the place of manufacture will be tested before or after installation, as applicable, or necessary to determine compliance with reference specifications and standards.
- C. Start-Up and Operational Test: The system shall be started up and initially operated with all components operating. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence.
- D. Extent of Field Tests: After installation and before acceptance, the work of this Section shall be subjected to all necessary field tests, including those specified, here and in Section 15010.
- E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 15010.

**"END OF SECTION"**

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**SECTION 15860**  
**CENTRIFUGAL FANS**

**PART 1: GENERAL**

**1.1 WORK INCLUDED**

- A. Backward inclined centrifugal fans.
- B. Forward curved centrifugal fans.
- C. Airfoil centrifugal fans.
- D. Utility/vent sets.
- E. Motors and drives.
- F. Belt guards.
- G. Inlet/outlet screens.
- H. Access doors.
- I. Scroll drains.

**1.2 SUBMITTALS**

- A. Submit under provisions of Section 01300.
- B. Provide product data on centrifugal fans and accessories as required for the work.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit sound power levels for both fan inlet and outlet at rated capacity.

**1.3 OPERATION AND MAINTENANCE DATA**

Include 4 copies of instructions for lubrication, motor and drive replacement, spare parts list and wiring diagrams.

**1.4 DELIVERY, STORAGE AND HANDLING**

Protect motors, shafts and bearings from weather and construction dust.

**PART 2: PRODUCTS**

**2.1 APPROVED MANUFACTURERS**

- A. Cook
- B. Greenheck

- C. Acme

## 2.2 GENERAL

- A. Fans used shall not decrease motor size, increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from specified criteria. Fans shall be capable of accommodating static pressure variations of plus or minus 10 percent.
- B. Base performance on sea level conditions.
- C. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas.

## 2.3 WHEEL AND INLET

- A. Backward Inclined: Steel construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
- B. Forward Curved: Steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of air flow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
- C. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy back plate die formed hollow airfoil shaped blades continuously welded at tip flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

## 2.4 HOUSING

- A. Heavy gage steel, spot welded for AMCA 99 designated Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
- B. Factory finish before assembly with enamel or prime coat. For fans handling air downstream of humidifiers, fabricate of galvanized steel. Prime coating on aluminum parts is not required.

## 2.5 UTILITY/VENT SETS

- A. General:
  - 1. Utility fan shall include housing, wheel, fan shaft, bearings and drives belt-guard as a factory assembled unit. Discharge arrangement as shown on drawings.
  - 2. All fans shall be tested and rated in accordance with AMCA Standard 210 and the Certified Ratings Program.
  - 3. Capacities and performance shall be as specified on drawings. See equipment schedule for details.
- B. Housing:

1. Fan housing shall be constructed of heavy-gauge steel with the side sheets fastened to scroll sheets with lock seam. A stiffener bead shall reinforce the sides and top of discharge.
2. Inlet collars shall extend beyond the fan housing to provide uninterrupted duct connection. Inlet collars shall be round with slip joint type connections.
3. Cutoffs and aerodynamically spun inlet cones shall be designed to provide for the smooth air flow through the fan with a minimum of turbulence.
4. Motor and bearings supports shall be adjustable in design and be constructed of heavy steel.
5. Provide a drain connection in housing for vertical discharge applications.

C. Fan Wheels:

1. Utility sets shall be furnished with forward-curved or backward inclined wheel as indicated in equipment schedule.
2. All blades shall be die cut and formed to provide identical, exact shapes.
3. Swaged hubs shall be furnished on all wheels.
4. All wheels shall be statically and dynamically balanced at factory after assembly.
5. Fan shafts shall be solid AISI C-1040 ground and polished steel. Close tolerance shall be maintained where shaft makes contact with bearings and fan wheel hub. All shafts shall have factory applied rust-preventive coating.

D. Bearings: Shall be self-aligning, grease lubricated, pillow block type. A contact seal shall be provided for grease retention and protection from contaminants. Bearings shall provide a minimum life of 200,000 hours at maximum operating conditions.

E. Drives: Shall be V-belt designed for 150% of motor horsepower and be complete with variable pitch motor drives. An exchange of sheaves and belts shall be supplied at no additional charge if required for air balance.

F. Acid Coating: Interior of fan and fan wheel to be coated for acid fume service with Heresite or Technicoat.

G. Accessories: Shall be as noted on drawings.

## 2.6 MOTORS AND DRIVES

A. Motors: As indicated in compliance with Section 15170.

B. Bearings: AFBMA 9, L-10 life at 50,000 hours heavy duty pillow block type, self-aligning, grease-lubricated ball bearings, or AFBMA 11 L-10 life at 120,000 hours pillow block type, self-aligning, grease-lubricated roller bearings.

C. Shafts: Hot rolled steel, ground and polished with key-way, protectively coated with lubricating oil.

- D. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
- E. Belt Guard: Fabricate to SMACNA Low Pressure Duct Construction Standards; of 12 gage 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication and use of tachometer with guard in place.

## 2.7 ACCESSORIES

- A. Inlet/Outlet Screens: Galvanized steel welded grid.
- B. Access Doors: Shaped to conform to scroll with quick opening latches and gaskets.
- C. Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.
- D. Bolted Access Doors or Panels: To be able to service motors, drives, bearings and/or fan wheel.

## 2.8 CEILING EXHAUST FANS

- A. Fan Unit: Direct driven forward curved centrifugal blower type, with formed galvanized steel housing lined with 1/2 inch acoustic insulation.
- B. Grille: Molded white aluminum with baked white enamel finish.
- C. The housing motors and blowers shall be completely removable by means of removable fasteners. The motor shall be permanently lubricated.
- D. Fans shall be equipped with factory suspension brackets, motor cover and insulated housings.

## PART 3: EXECUTION

### 3.1 INSTALLATION

- A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.
- B. Install fans as specified, with resilient mountings and flexible electrical leads. Refer to Section 15245.
- C. Install flexible connections specified in Section 15910 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one-inch flex between ductwork and fan while running.
- D. Install fan-restraining snubbers as required. Refer to Section 15245. Flexible connectors shall not be in tension while running.
- E. Provide safety screen where inlet or outlet is exposed.



- F. Pipe scroll drains to nearest floor drain.
- G. Provide back draft dampers on discharge of exhaust fans and as indicated.

**"END OF SECTION"**

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## **SECTION 15875**

### **VENTILATORS AND EXHAUST FANS**

#### **PART 1: GENERAL**

##### **1.1 WORK INCLUDED**

- A. Cabinet in-line and ceiling exhaust fans

##### **1.2 RELATED WORK**

- A. Section 15242 - Vibration Isolation.
- B. Section 15890 - Ductwork.
- C. Section 15910 - Duct Accessories.

##### **1.3 REFERENCES**

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

##### **1.4 QUALITY ASSURANCE**

- A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Conform to AMCA 99.

##### **1.5 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 01300.
- B. Provide product data on wall and roof exhausters, and ceiling and cabinet fans.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit sound power levels for both fan inlet and outlet at rated capacity.
- E. Submit manufacturer's installation instructions under provisions of Section 01300.

#### **PART 2: PRODUCTS**

##### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Cook.
- B. Greenheck.
- C. Exitaire
- D. Substitutions: Under provisions of Section 01600.

## 2.2 CABINET EXHAUST FANS

- A. Centrifugal Fan Unit: V-belt or direct driven, with formed galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- B. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- C. Grille: Molded white plastic or aluminum with baked white enamel finish.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings. An exchange of sheaves and belts shall be supplied at no additional charge if required for air balance.
- E. Drive assembly and wheel shall be hinged to swing out without dismantling the unit. The fan inlet shall be spun venturi throat overlapped by a backward curved centrifugal wheel with spun cone.
- F. Motors shall be totally enclosed fan cooled mounted on the hinged size exterior isolated from the air stream. See equipment schedule for horsepower characteristics.
- G. Fans shall be equipped with factory suspension brackets, motor cover and insulated housings.
- H. Motors:
  - 1. All motors shall be open drip-proof with ball bearings.
  - 2. Fractional horsepower motors shall be split phase or capacitor start and have a resilient base.
  - 3. Integral horsepower motors shall be induction with rigid base.
  - 4. See equipment schedule for horsepower and characteristics.
- I. Drives: Shall be v-belt designed for 150% of motor horsepower and be complete with variable pitch motor drives.
- J. Motors shall be selected at 15% greater than the brake horsepower, including drive loss, at design conditions.
- K. Accessories: Shall be as noted on the drawings.

## PART 3: EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

**"END OF SECTION"**

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## SECTION 15890

### DUCTWORK

#### PART 1: GENERAL

##### 1.1 WORK INCLUDED

- A. 2.0" pressure class ducts.
- B. 3.0" and 4.0" pressure class ductwork.
- C. Casings
- D. Fibrous glass ductwork.
- E. Duct cleaning (unless specified in Section 15880).

##### 1.2 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Pressure-Velocity Classification: Duct construction pressure classification shall comply with SMACNA HVAC Duct Construction Standards.

##### 1.3 REGULATORY REQUIREMENTS

- A. Duct system shall be constructed, installed, sealed and insulated as provided in Chapter 6 of the California Mechanical Code.
- B. Construct ductwork to NFPA 90A and NFPA 90B and NFPA 96 standards.

##### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Indicate duct fittings, particulars such as gages, sizes, welds and configuration prior to start of work for air distribution, kitchen hood exhaust, glass fiber duct systems as applies.
- C. Submit samples of diffuser outlet boxes.
- D. Submit manufacturer's installation instructions for glass fiber ducts.
- E. Submit manufacturer's certificate that installation of glass fiber ducts meets or exceeds recommended fabrication and installation requirements.

##### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site.
- B. Store and protect products.

## **PART 2: PRODUCTS**

### **2.1 APPROVED MANUFACTURERS - FOR FLEXIBLE DUCTS**

- A. Casco flexible duct.
- B. Thermaflex flexible duct.

### **2.2 MATERIALS**

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- B. Steel Ducts: ASTM A525 or ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq ft for each side in conformance with ASTM A90.
- C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.
- D. Flexible Ducts: Fully encapsulated, galvanized steel wire; rated to 2 inches WG positive and 0.5 inches WG negative. Flexible ducts shall consist of fully insulated blanket of fiberglass insulation R-6 (K = .29 @ 75 degrees F), sealed between two layers of tough polymer material with polyethylene jacket externally applied. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.

Flexible ducts shall be supported at or near mid-length with 2" wide 28 ga. steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets. The maximum length will be seven feet and can be used at the terminal ends only, except that flexible ducts properly installed may be used to cross-seismic joints without offsets.

- E. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.
- F. Fibrous Glass Ducts: UL 181; 1-1/2 inch thick rigid glass fiber with aluminum foil, glass scrim and kraft or plastic jacket vapor barrier; maximum 0.23 K value at 75 degrees F.
- G. Stainless Steel Ducts: ASTM A167, Type 304.
- H. Coating For Buried Ducts: PVC factory applied.
- I. Concrete Ducts: ASTM C14; hub and spigot concrete sewer pipe with ASTM C443 joints, rubber gaskets.
- J. Fasteners: Rivets, bolts or sheet metal screws.
- K. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape or heavy mastic.
- L. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end or continuously threaded.



- M. Exposed round ductwork shall be spiral lock seam with paintable surface. Unlined round duct shall be Uni-Seal by United McGill or equal. Lined round duct shall be Acousti-Line by United McGill or equal with 1" liner.

2.3 2.0" PRESSURE DUCTWORK (SUPPLY, RETURN, EXHAUST, DUCTWORK  
DOWNSTREAM OF TERMINAL BOXES, PLENUMS, CASING)

- A. Fabricate and support in accordance with SMACNA Pressure Duct Construction Standards for 2.0" pressure classification and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing and sealing for operating pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide [air foil] turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Provide easements where ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.
- F. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- G. Use crimp joints with or without bead for joining round duct sizes 12 inch and smaller with crimp in direction of airflow.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Special terminal boxes are required for all ceiling diffusers which exceed SMACNA Standards. Refer to details on the drawings. Square boxes with collar in top of box are not acceptable.

2.4 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and suitable for pressure classification or operating pressures as indicated or specified.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce doorframes with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 6 X 6 inch size.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage back facing and 22 gage perforated front facing with 3/32-inch diameter holes on 5/32-inch centers.

Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber media, on inverted channels of 16 gage.

### **PART 3: EXECUTION**

#### **3.1 INSTALLATION**

- A. Obtain manufacturer's inspection and acceptance of fabrication and installation of glass fiber ductwork at beginning of installation.
- B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.
- E. Coat buried, metal ductwork without factory jacket with one coat [and seams and joints with additional coat] of asphalt base protective coating.
- F. Insulate buried supply duct runs over 50 feet long with one-inch thick insulation covered with plastic vapor barrier.
- G. Encase buried metal ductwork in 3-inch minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete placement. Introduce no heat into ducts for 20 days following placement of concrete.
- H. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- I. Connect terminal units to medium or high-pressure ducts [directly or] with one-foot maximum length of flexible duct. Do not use flexible duct to change direction.
- J. Connect diffusers or troffer boots to ducts with 5 feet maximum length of flexible duct. Hold in place with strap or clamp.
- K. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel [or painted galvanized steel] for ductwork exposed to view and stainless steel or galvanized steel for ducts where concealed.
- L. Fibrous glass concealed ductwork may be substituted for internally or externally insulated or uninsulated low-pressure sheet metal ductwork.
- M. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- N. Neck connection of diffuser or register shall not be made directly into main trunks. Where direct duct neck connection are required due to space limitations, main duct shall be lined 5 feet each side of neck connection.

### 3.2 DUCTWORK APPLICATION SCHEDULE

<u>Air System</u>	<u>Material</u>
Up to 4.0" Low Pressure Supply (Heating Systems)	Steel
Up to 4.0" Pressure Supply (System with Cooling Coils)	Steel
Return and Relief	Steel
General Exhaust	Steel
Outside Air Intake	Steel
Combustion Air	Steel

### 3.3 ADJUSTING AND CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that may be harmed by excessive dirt with temporary filters or bypass during cleaning.
- B. Clean duct systems with high power vacuum machines. Protect equipment that may be harmed by excessive dirt with filters or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

**"END OF SECTION"**

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## **SECTION 15910**

### **DUCTWORK ACCESSORIES**

#### **PART 1: GENERAL**

##### **1.1 WORK INCLUDED**

- A. Volume control dampers.
- B. Fire dampers.
- C. Combination fire and smoke dampers.
- D. Back draft dampers.
- E. Air turning devices.
- F. Flexible duct connections.
- G. Duct access doors.
- H. Duct test holes.
- I. Cable controls systems and volume dampers.

##### **1.2 SUBMITTALS**

- A. Submit under provisions of Section 01300.
- B. Provide shop drawings for shop-fabricated assemblies indicated, including volume control dampers, duct access doors, and duct test holes. Provide product data for hardware used.
- C. Submit manufacturer's installation instructions for fire dampers and combination fire and smoke dampers where required on the drawings.

#### **PART 2: PRODUCTS**

##### **2.1 VOLUME CONTROL DAMPERS**

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards for pressure classification, in which it will be installed.
- B. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction and two gages heavier for sizes over 24 inches.

- C. Fabricate splitter dampers of double thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4-inch diameter rod in self-aligning, universal joint action flanged bushing with setscrew.
- D. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inch.
- E. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Provide locking, indicating quadrant regulators on single and multi-blade dampers. [Where rod lengths exceed 30 inches provide regulator at both ends.]
- H. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases or adapters.

## 2.2 APPROVED MANUFACTURERS - FIRE DAMPERS AND COMBINATION FIRE AND SMOKE DAMPERS

- A. California Aire.
- B. Ruskin.
- C. Pottorff.

## 2.3 FIRE DAMPERS

- A. Fire dampers shall be sized to maintain full duct area at the fire dampered opening, installed at the location indicated and provided where required by NFPA 90A or Code, and constructed in accordance with standard UL 55 specifications for fire doors. Provide fusible links of required temperature range and adequately sized access openings adjacent to each fire damper for servicing. All damper shall be listed approved by the State of California Fire Marshal's office.
- B. Fabricate in accordance with NFPA 90A and as indicated.
- C. Fabricate ceiling firestop flaps of galvanized steel, 22-gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side, and one layer on bottom side for round flaps, with locking clip.
- D. Fabricate ceiling dampers of galvanized steel, 22-gage frame, stainless steel closure spring and lightweight, heat retardant non-asbestos fabric blanket closure.
- E. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for low-pressure ducts up to 12 inches in height.
- F. Fabricate multiple blade fire dampers with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops and lock.

- G. Fusible links, UL 33, shall separate at 212 degrees F. Provide adjustable link straps for combination fire/balancing dampers.

## **2.4 COMBINATION FIRE AND SMOKE DAMPERS**

- A. Fabricate in accordance with NFPA 90A and as indicated.
- B. Provide factory sleeve for each damper. Install damper operator on exterior of sleeve and link to damper operating shaft.
- C. Fabricate with multiple blades with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade tops, lock and 1/2 inch actuator shaft.
- D. Operators shall be spring return pneumatic type suitable for operation on 0-20 psig instrument air or electric type suitable to operate on 120 V AC, 60 cycle, to match the type of control system. Operators shall be UL listed and labeled. Provide end switches to indicate damper position.

## **2.5 SMOKE DAMPERS**

- A. Fabricate in accordance with NFPA 90A and as indicated.
- B. Normally Closed Smoke Vent Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- C. Normally Open Smoke Damper: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices ensure positive closure for units mounted horizontally.
- D. Motorized Smoke Dampers: Curtain type, normally open with power on, close automatically when power is interrupted, UL-listed and labeled damper and damper operator.
- E. Electro Thermal Link: Fusible link, which melts when subject to local heat of 165 degrees F and from external electrical impulse; UL listed and labeled.

## **2.6 APPROVED MANUFACTURERS - BACKDRAFT DAMPERS**

- A. California Aire.
- B. Ruskin.
- C. Pottorff.

## **2.7 BACKDRAFT DAMPERS**

- A. Gravity back draft dampers furnished with air moving equipment, may be air moving equipment manufacturers standard construction.
- B. Fabricate multi-blade, parallel action gravity balanced back draft dampers of 16 gage galvanized steel, or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

**2.8 APPROVED MANUFACTURERS - AIR TURNING DEVICES**

- A. Duro Dyne.
- B. Elgin.
- C. or equal.

**2.9 AIR TURNING DEVICES**

- A. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

**2.10 APPROVED MANUFACTURERS - FLEXIBLE DUCT CONNECTIONS**

- A. Duro-Dyne.
- B. Elgin.
- C. or equal.

**2.11 FLEXIBLE DUCT CONNECTIONS**

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.
- C. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

**2.12 APPROVED MANUFACTURERS - DUCT ACCESS DOORS**

- A. California Aire.
- B. Ruskin.
- C. Pottorff.

**2.13 DUCT ACCESS DOORS**

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards suitable for pressure classification in which it will be installed.
- B. Review locations prior to fabrication.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one-inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.



- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not approved.

#### **2.14 DUCT TEST HOLES**

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

#### **2.15 BOWDEN CABLE CONTROL SYSTEMS AND VOLUME DAMPERS**

- A. Manual volume dampers, round or rectangular, with cable control or manual quadrant.
- B. General: All volume dampers above inaccessible ceilings shall be provided with Bowden remote cable controls as manufactured by Young Regulator Company, no known equal. Dampers mounted in diffuser inlets or requiring ceiling access panels for adjustment are not acceptable.
- C. Construction:
  - 1. Round dampers shall be butterfly design with heavy-duty spiral shell, 20 ga. "V" style blade, 1/2" round steel shaft and oil impregnated bronze bearings requiring no lubrication. Round dampers shall be Young Regulator Model 5020 or equal.
  - 2. Rectangular dampers shall be opposed blade design. Dampers up to 12" in height shall be constructed of .050 extruded aluminum double channel frame with stainless steel hardware including the damper slide. Blades shall be .050 extruded aluminum with longitudinal reinforcing beads. Blades shall be installed in individual Teflon blade bushings in the damper frame. Dampers shall be used in branch ducts with velocities under 750 fpm and maximum pressures of 2" w.g. Rectangular dampers shall be Young Regulator Model 820/830 or equal.
  - 3. For volume dampers above 12" in height, refer to control damper specification.
  - 4. Cable control manufacturer shall supply all necessary hardware for simple installation of remote cable control system including the Bowden aluminum angle bracket and the Bowden control hub to accommodate the cable control system mounted on the damper.
- D. Cable Control System: Cable control system shall consist of Bowden cable .054" stainless steel control wire encapsulated in 1/16" flexible galvanized spiral wire sheath to insure positive operation. Control kit shall be designed for use with internally or externally controlled round or rectangular dampers and shall consist of 14 ga. Steel rack and pinion gear drive to convert rotary motion to push-pull motion. Control shaft shall be D-style flattened 1/2" diameter with 265 degree rotation providing graduations for positive locking control and 1-1/2" linear travel. Cable shall terminate in a 1" or 3" inconspicuous access port, as indicated on plans. Twisting or rotating cable controls are not acceptable.

- E. Manual Quadrant: Manual quadrant shall be commercial quality, locking type for 3/8" square or 1/2" round shaft and shall be available on an extended base for externally insulated ductwork.

## **PART 3: EXECUTION**

### **3.1 INSTALLATION**

- A. Install accessories in accordance with manufacturer's instructions.
- B. Provide balancing dampers at points on supply, return and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.
- C. Provide balancing dampers on 3.0" and 4.0" pressure classification systems where indicated. Refer to Section 15930 - Air Terminal Units.
- D. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.
- F. Provide back draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps. Flexible connections shall have a minimum of 1" slack in fabric material with a minimum space of 1-1/2" between metal edging strips.
- H. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.
- I. Provide duct test holes where indicated and required for testing and balancing purposes.

**"END OF SECTION"**

**SECTION 15940**  
**AIR OUTLETS AND INLETS**

**PART 1: GENERAL**

**1.1 WORK INCLUDED**

- A. Diffusers
- B. Registers/grilles.

**1.2 REFERENCES**

- A. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. SMACNA - HVAC Duct Construction Standard.

**1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 01300.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application and noise level.
- D. Review requirements of outlets and inlets as to size, finish and type of mounting prior to submitting product data and schedules of outlets and inlets.

**PART 2: PRODUCTS**

**2.1 ACCEPTABLE MANUFACTURERS - CEILING DIFFUSERS**

- A. E.H.Price
- B. Metal Aire
- C. Kreuger
- D. Nailor
- E. Titus

**2.2 RECTANGULAR CEILING DIFFUSERS(SEE SCHEDULES)**

- A. Rectangular, adjustable pattern, stamped, multicore type diffuser to discharge air in 360-degree pattern with sectorizing baffles where indicated, manufactured by E.H.Price.
- B. Ceiling Diffusers: Shall be aluminum (or in steel) with baked off-white enamel over prime coat construction with separate opposed blade, Allen key-operated volume controls. Diffusers shall be provided with 24 x 24 extended shells or perforated panel suitable for

use in ceilings as indicated on drawings. Verify frame type with Architect prior to ordering. Diffusers shall be as manufactured by "E.H.Price" or approved equal.

- C. Provide frame as required for ceiling type.
- D. Fabricate of steel or aluminum with baked enamel finish, color as specified by Architect.
- E. Provide opposed blade damper, square to round neck adaptor and multi-louvered equalizing grid with damper adjustable from diffuser face.

#### **2.3 ACCEPTABLE MANUFACTURERS - CEILING REGISTERS/GRILLES(SEE SCHEDULES)**

- A. E.H.Price
- B. Metal Aire
- C. Kreuger
- D. Nailor
- E. Titus

#### **2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES(SEE SCHEDULES)**

- A. Streamlined blades, depth of which exceeds 3/4 inch spacing with spring or other device to set blades, manufactured by E.H.Price.
- B. Ceiling Return and Exhaust Registers and Grilles: E.H.Price all aluminum (or in steel) with baked off-white enamel over prime coat construction with opposed blade gang-operated volume control. Cores shall be without indents. Where located in tee ceilings provide with 24 x 24 extended shell or perforated panel as shown on drawing. Verify frame types with Architect before ordering.
- C. Frame type shall be compatible with ceiling.
- D. Fabricate of steel or aluminum with baked enamel finish, color as specified by Architect.
- E. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

#### **2.5 ACCEPTABLE MANUFACTURERS - WALL REGISTERS/GRILLES**

- A. E.H.Price
- B. Metal Aire
- C. Kreuger
- D. Nailor
- E. Titus

## **2.6 WALL SUPPLY REGISTERS/GRILLES(SEE SCHEDULES)**

- A. Streamlined and individually adjustable blades, depth of which exceeds 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection, manufactured by E.H.Price.
- B. Sidewall supply registers shall be "E.H.Price" double deflecting type with key operated opposed blade volume control aluminum (or in steel) with baked off-white enamel over prime coat construction. All sidewall supply registers shall be equipped with extractors.
- C. Fabricate 1-1/4 margin frame with countersunk screw mounting and gasket.
- D. Fabricate of steel or aluminum with 20 gage minimum frames and 22 gage minimum blades or aluminum extrusions with factory baked enamel finish.
- E. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

## **2.7 WALL EXHAUST AND RETURN REGISTERS/GRILLES(SEE SCHEDULES)**

- A. Streamlined fixed 45° angled deflecting vanes, depth of which exceeds 0.6 inch spacing horizontal face, manufactured by E.H.Price.
- B. Fabricate 1-1/4 inch margin frame with countersunk screw mounting.
- C. Fabricate of steel or aluminum with 20 gage minimum frames and 22 gage minimum blades with factory baked enamel finish.
- D. Where not individually connected to exhaust fans, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

## **PART 3: EXECUTION**

### **3.1 INSTALLATION**

- A. Install items in accordance with manufacturers' instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement.
- C. Install diffusers to ductwork with airtight connection.
- D. Provide balancing dampers on duct take-off to diffusers, grilles and registers, regardless of whether dampers are specified as part of the diffuser or grille and register assembly.
- E. Paint ductwork visible behind air outlets and inlets matte black.

**"END OF SECTION"**

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## **SECTION 15950**

### **DIRECT DIGITAL CONTROL SYSTEMS**

#### **PART 1: GENERAL**

##### **1.1 SECTION INCLUDES**

Furnish the district standard full BACnet-based system by Alerton Technologies (Climatec, Inc.) or Delta Building Technologies, including a Microsoft Windows NT operator's terminal, based on a distributed logic control system in accordance with this specification section. The operator's terminal and all global controllers shall communicate using the protocols and local area network (LAN) standards as defined by ANSI/ASHRAE Standard 135-1995, BACnet. Items of work included are as follows:

1. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications.
2. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
3. Implement the detailed design for all system-standard analog and binary objects, distributed control and system databases, graphic displays, logs and management reports based on control descriptions, logic drawings, configuration data and bid documents.
4. Design, provide and install all equipment cabinets, panels, data communication network cables needed, and all associate hardware.
5. Provide and install all interconnecting cables between supplied cabinets, logic controllers and input/output devices.
6. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.
7. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.
8. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup and commissioning.
9. Provide a comprehensive operator and technician training program as described herein.
10. Provide as-built documentation, operator's terminal software, diagrams and all other associated project operational documentation (such as technical manuals on approved media, the sum total of which accurately represents the final system.

11. Provide new dampers, valves and damper actuators. No used components shall be used as any part or piece of installed system.
12. The EMS shall provide web-based access as part of the standard installation. User shall be able to access all displays of real-time data that are part of the control system via a standard Web browser. Web browser shall tie into the network via owner-supplied Ethernet network connection.
13. The EMS hardware and software shall be fully expandable for a minimum of ten (10) school sites with an overall portion capacity of greater than 20,000 points.
14. Individual programming for stop/start of all HVAC equipment. The above list shall not be construed as a complete list of all controls required, but used as a guide for the major items to be furnished for a complete building EMS for control of all HVAC systems.

## 1.2 SYSTEM DESCRIPTION

### A. General Requirements

1. A distributed logic control system complete with Direct Digital Control (DDC) and Direct Analog Control (DAC) software shall be provided. System shall be based on ANSI/ASHRAE Standard 135-1995, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as AC units, etc., and any other listed equipment using BACnet-compliant components.
2. The processing system shall be in compliance with the BACnet standard: ANSI/ASHRAE 135-1995. The system shall use BACnet protocols and LAN types throughout and exclusively. Non-BACnet-compliant or proprietary equipment or systems shall not acceptable and are specifically prohibited.
3. All logic controllers for terminal units, air handlers, and central mechanical equipment shall communicate utilizing only BACnet communication protocols.
4. All logic controllers shall be fully programmable. That is, programmable controllers for every terminal unit, air handler, all central plant equipment, and any other piece of controlled equipment shall be provided. Programming tools shall be provided as part of operator work station for every controller supplied for the project.
5. The controls contractor shall assume complete responsibility for the entire controls system as a single source. He shall certify that he has factory-trained technical personnel on staff under his direct employ on a daily basis. These employees shall be qualified to engineer, program, debug and service all portions of the BACnet based control system. This shall include operator's terminal, global controllers, routers, terminal unit controllers, sensors and all other sections of the system.
6. The bid shall be based on the district standard BACnet "open protocol" systems by Alerton Technologies (Climatec, Inc.) or Siemens Building Technologies. The new system shall interface seamlessly with the district maintenance and operations central computer work station including programming, graphic displays and naming conventions.



B. Basic System Features

1. Zone-by-zone direct digital logic control of temperatures, scheduling, optimum start, equipment alarm reporting and override timers for after hours usage. A zone is the area served by one (1) HVAC logic controller unit.
2. Operator's terminal software shall be Microsoft Windows 95/98 or Windows NT based. The EMCS application program shall be written to communicate specifically utilizing BACnet protocols. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software shall support Windows Active X interface. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or operating systems other than that described above are strictly prohibited. Operation of the terminal software shall be simple and intuitive.
3. Operator's terminal software shall contain an easy-to-operate system allowing configuration of system-wide controllers, including management and display of the controller programming. This system shall provide the capability to configure controller binary and analog inputs/outputs.
4. Operator's terminal operating system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation and graphics design packages. Graphics generation shall be done using standard Windows packages. No proprietary graphics generation software shall be needed.
5. When specified, at least one (1) operator's terminal shall be equipped to act as a system server. This system server shall store copies of loadable software for all field components and shall be capable of automatic or manual re-loading of such software into the field components as required. The system server shall also gather and archive system operating data, such as trend logs, energy logs and other historical operating data.
6. Complete energy management firmware, including global control strategies and logging routines for use with total control system shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only.
7. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.
8. Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included with the system.
9. The complete system, including but not limited to, terminal unit controllers, global controllers and operator's terminals, shall auto-restart without operator intervention, on resumption of power after a power failure. Database stored in global controller memory shall be battery-backed up for a minimum of one (1) year. Logic controllers for all air handlers and all unitary equipment shall utilize

EEPROM for all variable data storage. Batteries on unitary controllers shall not be allowed.

10. System design shall be modular and of proven reliability.
11. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.
12. System shall be capable of equipment run time totalization of fans, heaters, boilers, etc., and capable of alarm generation and alarm dialout to remote sites.
13. Room sensors shall be provided with digital readout that allows the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. In conjunction with a unitary logic controller, user shall also be able to start and stop unit from the digital sensor.
14. Communication wiring for field controllers shall not be run in star patterns.
15. All DDC hardware and software shall be designed and manufactured by United States corporations. All hardware shall be Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the United States and Canada, with integral labels showing rating.

### 1.3 QUALITY ASSURANCE

- A. Responsibility: The supplier of the HVAC digital logic control system shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.
- B. Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor and all other DDC components shall be individually tested by the manufacturer prior to shipment.
- C. Tools, Testing and Calibration Equipment: The control system supplier shall provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the control system.
- D. The systems control contractor shall have been in business a minimum of five (5) years and be the authorized installing contractor for the manufacturer of the BACnet components.

### 1.4 REFERENCE STANDARDS

- A. The latest edition of the following standards and codes in affect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
  1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
  2. ANSI/ASHRAE Standard 135-1995, BACnet.
  3. Uniform Building Code (UBC), including local amendments.

4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the United States.
  5. National Electrical Code (NEC).
  6. FCC Part 15, Subpart J, Class A.
  7. EMC Directive 89/336/EEC (European CE Mark).
- B. City, county, state and federal regulations and codes in effect as of contract date.
- C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections and certifications required for his work, and arrange for all necessary approvals by the governing authorities.

#### 1.5 SUBMITTALS

A. Drawings

1. The system supplier shall submit engineering drawings, control sequence and bills of material for approval.
2. Drawings shall be submitted in the following standard sizes: 11" x 17" (ANSI B).
3. Provide 11" x 17" ACAD floor plans showing locations of all panels and devices.
4. Eight (3) complete sets (copies) of submittal drawings shall be provided.
5. Drawings shall be available on floppy disk or CD-ROM, as specified.

B. System Documentation: System documentation by the vendor shall include the following as a minimum:

1. System configuration diagrams in simplified block format.
2. All input/output object listings and an alarm point summary listing.
3. Electrical drawings that show all system internal and external connection points, terminal block layouts and terminal identification.
4. Manufacturer's instructions and drawings for installation, maintenance and operation of all purchased items.
5. Overall system operation and maintenance instructions, including preventive maintenance and troubleshooting instructions.
6. For all system elements – operator's terminal(s), global controller(s), logic controllers, routers, repeaters and converters – provide BACnet Protocol Implementation Conformance Statements (PICS) as per the following sample.
7. Provide complete description and documentation of any proprietary services and/or objects used in the system.

## 1.6 WORK STATION

Provide all necessary connection for the work station and laptop computer provided by the District. Coordinate with District for location of connections.

## 1.7 SENSORS AND MISCELLANEOUS DEVICES

### A. Temperature Sensors

All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable. Wall sensors to be housed in tamper proof enclosures. Duct sensors to be electronically identical, housing suitable for the application. Metal guards shall be provided as shown on drawings.

### B. Digital Display Wall Controller (DWC)/Temperature Sensor

1. Sensor shall contain a backlit LCD digital display and user function keys, along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use – all within limits as programmed by building operator. Controller shall also allow service technician access to hidden functions as described in sequence of operation.
2. The DWC shall simultaneously display room setpoint, room temperature, outside temperature and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time count down shall be automatic, but may be reset to zero by occupant from the DWC. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of DWC displays and function keys in field service mode and in normal occupant mode. Provide digital display wall controllers as specified in point list.
5. Field service mode shall be customizable to fit different applications. If DWC is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the DWC.

- C. Wall Sensor: Standard wall sensor shall use solid state sensor identical to DWC and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for setpoint adjustment and jack for plug-in of DWC for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. All functions of DWC shall be available through wall sensor port.

### D. Compact Operator Terminal (COT)

1. The COT is a small wall or panel-mounted operator terminal that connects directly to the BACnet LAN. The communications design and messaging structure shall comply with ANSI/ASHRAE Standard 135-1995, BACnet.
2. Each COT shall have a keypad and an adjustable backlit LCD, with a simple menu structure to give occupants and technicians intuitive access to system information. It shall have a minimum 4-line by 20-character display to allow an operator to query and adjust system values.
3. The system shall allow the connection of up to 16 COT's to each Global Controller. The operator shall have the ability to connect to each COT with a laptop computer via an RS-232 cable to gain system access, troubleshooting and COT display programming.
4. If a Windows-based PC front-end Operator's Terminal is not specified above, then the COT shall serve as the site Operator's Terminal. If a Windows-based PC front-end Operator's Terminal will be present, then provide COT's in the locations shown on the drawings.

**PART 2: PRODUCTS**

NOT USED

**PART 3: EXECUTION**

**3.1 EXAMINATION**

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this section may properly commence.
- B. Notify the owner's representative in writing of conditions detrimental to the proper and timely completion of the work.
- C. Do not begin work until all unsatisfactory conditions are resolved.

**3.2 INSTALLATION (GENERAL)**

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections, installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

**3.3 LOCATION AND INSTALLATION OF COMPONENTS**

- A. Locate and install components for easy accessibility; in general, mount 60 inches above floor with 3'-0" clear access space in front of units. Obtain approval on locations from owner's representative prior to installation.
- B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
- C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

- D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections – sized to suite pipe diameter without restricting flow.

### 3.4 INTERLOCKING AND CONTROL WIRING

- A. Provide all interlock and control wiring complete with raceways. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.
- B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.
- C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.
- D. Provide auxiliary pilot duty relays on motor starters as required for control function.
- E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings – coordinate with electrical contactor.
- F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

All binary and analog object types (including zones) shall have the capability to be automatically trended.

- G. Underground raceways are by Division 16 signal conductors under this section.

### 3.5 FIELD SERVICES

- A. Prepare and start logic control system under provisions of this section.
- B. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one (1) year, or as specified.
- D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

### 3.6 TRAINING

- A. Provide application engineer to instruct owner in operation of systems and equipment.
- B. Provide system operator's training to include (but not limited to), such items as the following: modification of data displays, alarm and status descriptors, requesting data,

execution of commands and request of logs. Provide this training to a minimum of three (3) persons.

- C. Provide on-site training above as required, up to sixteen (16) hours as part of this contract.

### 3.7 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 15010.
- B. Demonstrate complete operating system to owner's representative.
- C. Provide certificate stating that control system has been tested and adjusted for proper operation.

"END OF SECTION"

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## **SECTION 15990**

### **TESTING, ADJUSTING AND BALANCING**

#### **PART 1: GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Testing, adjustment and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.

##### **1.2 RELATED SECTIONS**

- A. Section 15890 - Ductwork
- B. Section 15940 - Air Outlets and Inlets

##### **1.3 REFERENCES**

- A. AABC - National Standards for Field Measurement and Instrumentations, Total System Balance.
- B. NEBB – Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

##### **1.4 SUBMITTALS**

- A. Submit under provisions of Section 01300.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Submit test reports.
- D. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

##### **1.5 REPORT FORMS**

- A. Submit reports on AABC National Standards for Total System Balance.

B. Forms Shall Include the Following Information:

1. Title Page:

- a. Company name
- b. Company address
- c. Company telephone number
- d. Project name
- e. Project location
- f. Project Architect
- g. Project Engineer
- h. Project Contractor

2. Instrument List:

- a. Instrument
- b. Manufacturer
- c. Model
- d. Serial number
- e. Range
- f. Calibration date

3. Air Moving Equipment:

- a. Location
- b. Manufacturer
- c. Model
- d. Air flow, specified and actual
- e. Return airflow, specified and actual
- f. Outside airflow, specified and actual
- g. Total static pressure and total external, specified and actual
- h. Inlet pressure
- i. Discharge pressure
- j. Fan RPM

4. Exhaust Fan Data:
  - a. Location
  - b. Manufacturer
  - c. Model
  - d. Air flow, specified and actual
  - e. Total static pressure (total external), specified and actual
  - f. Inlet pressure
  - g. Discharge pressure
  - h. Fan RPM
5. Electric Motors:
  - a. Manufacturer
  - b. HP/BHP
  - c. Phase, voltage, amperage; nameplate, actual, no load.
  - d. RPM
  - e. Service factor
  - f. Starter size, rating, heater elements
6. V-Belt Drive:
  - a. Identification/location
  - b. Required driven RPM
  - c. Driven sheave, diameter and RPM
  - d. Belt, size and quantity
  - e. Motor sheave, diameter and RPM
  - f. Center to center distance, maximum, minimum and actual
7. Air Distribution Test Sheet:
  - a. Air terminal number
  - b. Room number/location
  - c. Terminal type

- d. Terminal size
- e. Area factor
- f. Design airflow
- g. Test (final) airflow
- h. Percent of design air flow

8. Cooling Coil Data:

- a. Identification/number
- b. Location
- c. Service
- d. Manufacturer
- e. Air flow, design and actual
- f. Entering air DB temperature, design and actual
- g. Entering air WB temperature, design and actual
- h. Leaving air DB temperature, design and actual
- i. Leaving air WB temperature, design and actual
- j. Water flow, design and actual
- k. Water pressure drop, design and actual
- l. Entering water temperature, design and actual
- m. Leaving water temperature, design and actual
- n. Air pressure drop, design and actual

9. Flow Measuring Station:

- a. Identification/station
- b. Location
- c. Size
- d. Manufacturer

- e. Model
  - f. Design flow rate
  - g. Design pressure drop
  - h. Actual/final pressure drop
  - i. Actual/final flow rate
  - j. Station calibrated setting
10. Sound Level Report:
- a. Location
  - b. Octave bands - equipment off
  - c. Octave bands - equipment on
11. Vibration Test: Air Moving Equipment
- a. Location of points:
    - 1) Fan bearing, drive end
    - 2) Fan bearing, opposite end
    - 3) Motor bearing, center (if applicable)
    - 4) Motor bearing, drive end
    - 5) Motor bearing, opposite end
    - 6) Casing (bottom or top)
    - 7) Casing (side)
  - b. Test readings:
    - 1) Horizontal, velocity and displacement
    - 2) Vertical, velocity and displacement
    - 3) Axial, velocity and displacement
  - c. Normally acceptable readings, velocity and acceleration
  - d. Unusual conditions at time of test
  - e. Vibration source (if non-complying)

1.6 PROJECT RECORD DOCUMENTS

Submit record documents.

## 1.7 QUALITY ASSURANCE

- A. Agency shall be company specializing in the adjusting and balancing of systems specified in this Section with minimum three years experience. Perform Work under supervision of AABC or NEBB Certified Test and Balance Engineer.
- B. Total system balance shall be performed in accordance with AABC "National Standards for Field Measurement and Instrumentation, Total System Balance" or NEBB "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems".
- C. Provide a Quality Assurance Program to assure Owner and specify design progressional that the testing, adjusting and balancing will perform in accordance with the current applicable NEBB Procedual Standards, or equivalent by AABC. Program shall remain in effect or 12 months after submission of the "Final" balance report to the specifying design firm.

## 1.8 SEQUENCING AND SCHEDULING

Sequence work to commence after completion of systems and schedule completion of work before date of Substantial Completion.

## 1.9 AGENCY QUALIFICATIONS

Testing, adjusting and balancing agency shall be certified by AABC or NEBB. Agency must be an independent agency and not a subsidiary of, or affiliated with any firm who performs services other than testing, adjusting and balancing.

## PART 2: PRODUCTS

NOT USED

## PART 3: EXECUTION

### 3.1 EXAMINATION

- A. Before commencing work, verify that systems are complete and operable.
- B. Report any defects or deficiencies noted during performance of services to the Engineer.
- C. Promptly report abnormal conditions in mechanical systems or conditions, which prevent system balance.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.
- F. ***Air balance not to commence until ductwork shop drawings have been submitted to the design engineer for review acceptance.***

### 3.2 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.
- B. Provide additional balancing devices as required.

### 3.3 INSTALLATION TOLERANCES

- A. Adjust air moving systems to plus or minus 5 percent for supply systems and plus or minus 10 percent for return and exhaust systems from figures indicated.

### 3.4 ADJUSTING

- A. Recorded data shall represent actually measured or observed condition.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Provide labor at no additional cost to the Owner to change sheaves and belts as required to accomplish specified fan performance. Mechanical Contractor to provide material as required.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes and restoring thermostats to specified settings.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Architect.

### 3.5 AIR SYSTEM PROCEDURE

- A. Adjust distribution systems to provide required or design supply, return and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.



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## SECTION 16005

### ELECTRICAL DEMOLITION

#### Part 1 - GENERAL

##### 1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to, the following:

1. Examine all other sections for work related to those other sections and required to be included as work under this section.
2. General provisions and requirements for electrical work.

##### 1.02 GENERAL SUMMARY OF ELECTRICAL WORK

- A. Refer to the drawings of other trades for additional details which affect the proper installation of this work. Diagrams and symbols showing electrical connections are diagrammatic only. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.
- B. Before submitting a bid, the Contractor shall familiarize himself with all features of the building drawings and site drawings which may affect the execution of the work. No extra payment will be allowed for failure to obtain this information.
- C. If there are omissions or conflicts between the drawings and specifications, clarify these points with the Architect before submitting bid.

##### 1.03 LOCATIONS OF EQUIPMENT

- A. The drawings indicate diagrammatically the existing locations or arrangement of outlets, equipment, lighting, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work so as to secure the best possible removal of equipment and to overcome local difficulties due to space limitations or interference of structure conditions encountered.
- B. The locations of existing utilities, building, equipment shown on the drawings to approximate. Verify exact locations and routing of existing systems in the field.
- C. Coordinate and cooperate in every way with other trades in order to avoid interference and assure a satisfactory job.

##### 1.04 PERMITS

- A. Take out and pay for all required permits, inspections and examinations without additional cost to the Owner.

##### 1.05 QUALITY ASSURANCE

- A. Work and materials in full accordance with the latest rules and regulations of the California Administrative Code Title 24, Part 3 "Basic Electrical Regulations", Title 8

"Division of Industrial Safety", the National Electrical Code, the National Life Safety Code, and other applicable state laws and regulations.

- B. Keep a copy of all applicable codes available at the job site at all times while performing work under this section. Nothing in plans or specifications shall be construed to permit work not conforming to the most stringent of codes.

#### 1.06 JOB CONDITIONS - PROTECTION

- A. Protect all work, materials and equipment from damage from any cause whatever and provide adequate and proper storage facilities during the progress of the demolitions work. Provide for the safety and good condition of all the work until final acceptance of the work by the Owner.

#### 1.07 TEMPORARY ELECTRICAL POWER

- A. The Contractor shall provide his own temporary construction lighting and power as required in areas where work is being performed, when normal site power is disrupted. Temporary power arrangements, outages, installation, work schedules, etc., shall be submitted in writing three weeks prior to requested outage date, and approved by the Owner prior to start of work.

#### 1.08 POWER, LIGHTING, TELEPHONE DEMOLITION

- A. Remove all existing lighting fixtures with related conduit and wiring to source. Store lighting fixtures in a secure storage area, coordinate with the facilities project manager.
- B. Provide electrical demolition as required. Refer to demolition drawings for locations and extent of demolition required contractor shall visit site prior to bid to determine extent of work involved.
- C. Set up a storage area to house all removed and salvage materials. Storage area must be coordinated with facilities project manager.
- D. Contractor shall remove all equipment along with related conduit and wiring back to source. Dispose of all materials except for items indicated for salvage under demolition drawings of electrical, mechanical and architectural.
- E. Contractor shall remove all data/telephone outlet boxes, terminal boards etc. with related cabling back to source, and remove from site.
- F. Main switchboard along with S.C.E. transformer pad shall be maintained during demolition construction. At no time shall the normal and/or emergency power be de-energized for the existing facility.

END OF SECTION

## SECTION 16010

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. This Section provides the Basic Electrical Requirements which supplement the General Requirements of Division 1 and apply to all Sections in Division 16.

##### 1.02 RELATED SECTIONS

- A. Excavating, Backfilling and Compacting for Utilities: Section 02222.
- B. Cast-in-Place Concrete: Section 03300.

##### 1.03 BASIC ELECTRICAL REQUIREMENTS

###### A. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, the Electrical Drawings are essentially diagrammatic. The size and location of equipment is indicated to scale whenever possible. Contractor shall verify all conditions, data and information as indicated on Drawings and in Specifications Sections where Electrical work is required.
2. The Electrical Drawings indicate required size and points of termination of conduits, number and size of wires, and suggest proper route for conduit. It shall be responsibility of Contractor to install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and meet all applicable code requirements. Routing of conduits may be changed, if approved by the District Electrical Inspector, provided that the length of any conduit run is not increased or decreased more than 10% of the length indicated on Drawings.
3. It is intended that outlets be located symmetrical with Architectural elements notwithstanding fact that locations indicated on Drawings may be distorted for clarity.
4. The Architectural and Structural Drawings take precedence over the Electrical Drawings in the representation of general construction work. Drawings of the various trades take precedence in representation of work of those trades. Contractor shall refer to all Drawings to coordinate the Electrical work with work of other trades.

###### B. Terminology:

1. Term "signal system" shall apply to clock, bell, fire alarm, annunciator, sound, public address, buzzer, public telephone, television, inter-communication, and security systems.
2. Term "low voltage" shall apply to systems operating at 600 volts and under.
3. Term "provide" used on Drawings and elsewhere in the Specifications shall be considered to mean "furnish and install".
4. Term "UL" means Underwriters Laboratories Inc.

###### C. Ordinances and Regulations:

1. Electrical work shall meet requirements of local authorities having jurisdiction including municipal ordinances, City Building code, the California Code of Regulations, Title 24, the Safety Orders of the State Division of Industrial Safety, and the Fire and Panic Safety Standards of the State Fire Marshal. Material and labor shall conform to Regulations of the National Board of Fire Underwriters for Electrical Wiring and Apparatus. All new material shall be "UL" listed or shall be listed by the City of Los Angeles, including amendments thereto, effective on date of openings bids for work, is hereby made a part of this Specification, and shall apply to all work both within and outside the City of Los Angeles, except for those portions which conflict with requirements of local authorities.
2. Electrical work shall meet requirements of latest California Electrical Code as indicated and specified.

D. Structural Considerations for Conduit Routing:

1. Where conduits are to pass through or will interfere with any Structural member, or where notching, boring or cutting of the structure is necessary, or where special openings are required through walls, floors, footings, or other buildings elements, to accommodate the electrical work, such work shall conform to State Building Code, Part 2, Title 24, Section 2606 for conduits and pipes embedded in concrete and Section 2517 (g) 8, 9, for notches and bored holes in wood; for steel, as detailed on the Structural Drawings.
2. Where a concrete encasement for underground conduit abuts a foundation wall or underground structure which the conduits enter, encasement shall, rest on a haunch integral with wall or structure, or shall extend down to footing projection, if any, or shall be doweled into structure unless otherwise indicated. Underground structures shall include manholes, pull boxes, vaults and buildings.
3. Holes required for conduit entrances into speaker poles, floodlight poles or other poles, shall be drilled and conduit nipple or coupling shall be welded to poles. Welds shall be by the electric arc process and shall be continuous around nipple or coupling.

E. Electrically Operated Equipment and Appliances:

1. Equipment and Appliances Furnished by Contractor:

- a. The Electrical work shall include furnishing and installing wiring enclosures for, and the complete connection of all electrically operated equipment and appliances and any electrical control devices which are specified to be furnished and installed in this or other Electrical Sections of these Specifications, except Electrical work specified or indicated to be in the Mechanical work. All wiring enclosures shall be installed concealed except where exposed work is indicated on Electrical Drawings.
- b. Connections shall be made as necessary to completely install equipment ready for use. Equipment shall be tested for proper operation and, if motorized, for proper rotation. If outlets of incorrect Electrical characteristics or if any equipment fails to operate properly, Contractor shall report to the District=s Inspector in writing, listing buildings and rooms in which located, the name, make and serial number of equipment, and a description of defect.

2. Equipment and Appliances Furnished by Others:

- a. Equipment and appliances indicated on Drawings as N.I.C. (Not in

Contract), "Furnished by Others", or "Furnished by the District", will be delivered to the Site. Required Electrical connections shall be made for all such equipment and appliances in accordance with accepted trade practices under direction of the Electrical Engineer. All motorized equipment will be furnished factory wired to a control panel or junction box unless otherwise indicated. Appliances will be furnished equipped with portable cord and cap. Provide disconnect switches where required.

- b. Connections to equipment furnished under other Sections of this Specification shall be part of the Electrical Work. Work shall include internal wiring, installation, connection and adjustment of bolted drive motors in which the motor is supplied as a separate unit and connections only for equipment furnished with factory installed internal wiring, except as further limited by Drawings and other Sections of this Specification. Work shall include furnishing and installing suitable outlets, disconnecting devices, starters, push button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete Electrical installation. Work shall also include furnishing and installing conduit and outlet box, if needed for control system, furnished under Mechanical. Devices and equipment furnished shall be of same type used elsewhere on job or as specified.
- c. Electrical equipment furnished under other Sections of this Specification for installation and connection under work of this Section shall be delivered to the installation location by the Contractor furnishing the equipment.
- d. Mechanical equipment furnished under other Sections of this Specification, and requiring Electrical connection under this Section, will be set in place by Contractor furnishing equipment.
- e. Suitability and condition of equipment furnished by other Sections of this Specification shall be determined in advance of installation. Immediate notice of damage, unsuitability or lack of parts shall be given to the Architect.

F. Protection of materials

- 1. Provide for safety and good condition of all materials and equipment until final acceptance of project by the Owner. Protect all materials and equipment from damage and provide adequate and proper storage facilities during progress of work. All damaged and defective work shall be replaced prior to final inspection.

G. Cleaning

- 1. Exposed parts of Electrical work shall be left in a neat, clean, usable condition. Finished painted surfaces shall be unblemished and metal surfaces shall be polished.
- 2. Thoroughly clean all parts of apparatus and equipment. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials. Remove grease and oil spots with solvent. Such surfaces shall be wiped and all corners and cracks scraped out. Exposed rough metal work shall be smooth, free of sharp edges, carefully steel brushed to remove rust and other spots, and left in proper condition to receive finish painting.
- 3. Contractor shall remove from the Site all debris and rubbish caused by the Electrical work. He shall thoroughly clean building of dirt, debris, rubbish, marks, etc., caused by performance of work.

## PART 2 - PRODUCTS - NOT USED

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF EQUIPMENT AND APPLIANCES

- A. Conduit stubs for equipment shall be terminated in a coupling flush with finished floor and shall be extended with rigid metallic conduit to a motor starter or junction box on the equipment.
- B. If connection is from a flush wall-mounted junction box, install a weatherproof universal box extension and adaptor by Bell Electric Company, and extend with rigid metallic conduit to motor starter or junction box on equipment.
- C. All exposed final connections to equipment shall be by a water tight flexible conduit, unless otherwise indicated. A maximum of 36" of flexible conduit may be used except that all extensions from flush floor couplings shall be rigid conduit to a distance not less than 6" above floor.
- D. Flexible conduit for all motors, shop and cafeteria equipment and other equipment, including HVAC equipment, shall be liquid-tight, flexible conduit, and shall contain a code size insulated green bond wire.
- E. All exposed conduit shall be run vertically and horizontally following general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe straps.
- F. Connectors for flexible steel conduit shall be the type which threads into convolutions of conduit. Connectors for water-tight flexible metal conduit shall be approved for such use and shall be installed to make a watertight connection.

### 3.02 CLOSE OUT OF PROJECT

- A. Contractor shall provide the following items at the end of the project:
  - 1. As-built drawings on AutoCAD R.14 or 2002 on disk with one (1) set of prints.
  - 2. Ground fault test report.
  - 3. Three (3) sets of all warranty information with fixture cuts of equipment in a book.

END OF SECTION



## SECTION 16050

### BASIC ELECTRICAL MATERIALS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Boxes, Enclosures, Keys and Locks.
- B. Receptacles and Switches.
- C. Identifications and Signs.

##### 1.02 RELATED SECTIONS

- A. Basic Electrical Requirements: Section 16010.

##### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300: Submittals.

#### PART 2 - PRODUCTS

##### 2.01 BOXES, ENCLOSURES, KEYS AND LOCKS

###### A. Outlet Boxes and Fittings:

1. Outlet boxes used in concealed work shall be galvanized or sheardized steel, pressed or welded type, with knockouts.
2. In exposed work, outlet boxes and conduit fittings required where conduit runs change direction or size, shall be cast metal with threaded cast hubs cast integral with box or fitting. Boxes and fittings shall not have unused spare hubs except as otherwise indicated or specified.
3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium plated or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of cracks, gas holes, flaws, excessive shrinkage and burnt-out sand.
4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting used.
5. Light fixture outlets shall be 4" octagon, 4" square, or larger, depending upon number of wires or conduits therein, and shall be equipped with 3/8" malleable iron fixture studs, and plaster rings. Plaster rings shall have round opening with 2 ears drilled 2-23/32" center to center.
6. For local switch outlets use 4" square boxes for single gang, 5" square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than 2 switches.
7. For all receptacle, clock, bell, fire station, speaker, thermostat and telephone outlets, use 4" square boxes or larger, if necessary, with single gang plaster rings. For television outlets, use 4-gang deep boxes and 4-gang plaster rings. For buzzer, communication switch, and handset outlets, use 4" square boxes with single gang or larger plaster rings.

8. Plaster rings shall be provided on all flush mounted outlet boxes except where otherwise indicated or specified. All plaster rings shall be same depth as finished surface.
9. In existing plywood wall or drywall construction, and where flexible steel conduit is fished into walls, one-gang and two-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with a flat head screw in each plaster ear screw hole. Boxes fastened to gypsum board shall be "Gripsite" by Raco.
10. Factory made knock-out seals shall be installed to seal all box knock-outs which are not intact.
11. At each location where flexible conduit is extended from a flush outlet box, provide and install a weatherproof universal box extension adapter by Bell Electric Company.

B. Junction and Pull-Boxes:

1. Junction and pull-boxes, in addition to those indicated, shall only be used where absolutely necessary.
2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsional and deflecting forces. Boxes shall have auxiliary angle iron framing where necessary to ensure rigidity. Covers shall be fastened to box with a sufficient number of brass machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws at Site if boxes are not installed plumb. All surfaces of pull and junction boxes and covers shall be given one coat of metal primer, and one coat of aluminum paint.
3. Weatherproof pull and junction boxes shall conform to foregoing for interior boxes with following modifications: Cover of flush mounting boxes shall have a weather-tight gasket cemented to and trimmed even with cover all around. Surface or semi-flush mounting pull and junction boxes shall be UL approved as rain-tight and shall be complete with threaded conduit hubs. All exposed portions of boxes shall be galvanized and finished with a prime coat and coat of baked-on grey enamel.
4. All junction and pull-boxes shall be rigidly fastened to the structure and shall not depend on conduits for support.
5. Underground Concrete Pull Boxes:
  - a. Precast Concrete Pull Boxes. Concrete pull boxes shall be traffic type, reinforced for H- 20 Traffic bridge loading, precast concrete. Pull boxes with inside dimensions 2'-0"x 3'-0" x 3'-0"D shall consist of a base section, top ring and cover. Base section shall have two 10"x10" knockouts in each 3'-0" side, and one 20"x20" knockout in each 2'-0" side. Pull boxes with inside dimension 4'-0" x 4'-0" x 4'-0"D shall consist of a base section, mid section, topping, and cover. Base section shall have two 8"x 16" knockouts on each of two opposite sides, and one 20" x 20" knockout on each of the other two opposite sides. All pull boxes shall have a minimum of 6" diameter sump knockout, and 1" diameter ground rod knockout. In each pull box, furnish and install cable racks on walls. Each rack shall be equipped with 3 porcelain cable holders on a vertical steel mounting bar. Each pull box shall have 3/4" diameter pull irons. Covers shall be traffic type consisting of steel safety plate bolted to frame. Covers shall be marked "Electrical", "Power" "Telephone",

"Signal" or "Ground", as required. Pull boxes shall be as manufactured by Quickset, or approved equal.

- b. Provide end bells in all duct entrances. Terminate each metal conduit with insulated bushing having grounding terminal, O.Z. Type "Big"
  - c. Place pulling irons on opposite walls and below horizontal centerlines of ducts and bricked-up openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
  - d. Damp-proof exterior walls and tops of below grade with two coats of bituminous coating. A. C. Horn Company "Dehydrating" No. 4, Sonneborn Sons, Inc., "Hydrocide 648", Toch Brothers "RIW Marine Cement Semi-Mastic", or approved equal.
  - e. Install a floor drain in every concrete pullbox into a sump containing 10 cubic feet of 1" crushed rock; minimum size 48" deep and 36" diameter. Provide 36" length of tile pipe extending down into the sump. Provide a grille over the top opening of pipe.
  - f. Install a 3/4" diameter, 10'-0" copperweld steel ground rod in every power concrete pull- box. Locate near a wall with 6" projection above floor for ground clamps. Permanently and effectively ground all metal equipment cases, cable racks, etc., in all pull boxes.
  - g. Provide a 6" deep sand base under each pull box.
  - h. Identify all power and signal cables by tagging in all manholes and pull boxes. Tie securely to cables with nylon cord or insulated type TW wire. Tie so that turns of wires do not form a closed electrical circuit.
  - i. Top of steel plate shall have a minimum coefficient of static friction of 0.5 for either wet or dry conditions, when tested for any shoe sole material. Testing and certification of the friction factor shall be conducted by an independent testing laboratory approved by the engineer, under the direction of a registered Civil or Quality Engineer. Testing shall conform to ASTM D1047 or F489 or F609, or other procedure approved by the Engineer.
6. Underground utility boxes shall be reinforced concrete with non-setting shoulders to prevent settlement following installation. Boxes shall be furnished with cast iron cover with finger hole, size as indicated on Drawings. Utility boxes shall be as manufactured by Quickset, or approved equal.
7. Manholes, vaults and pull-boxes required by utility company, and installed by Electrical Contractor, shall meet all requirements of utility company.

C. Floor Outlets:

- 1. All floor outlets, except extension outlets, shall be Harvey Hubbell Inc. #B-2503, adjustable, cast iron, watertight floor boxes with flush brass floor plates, and shall be set to finish flush with final floor covering, whether it be concrete, wood, resilient floor covering, or other.
- 2. Telephone, microphone, and buzzer above floor outlets shall be equipped with a brass 2-1/8" flush cap, a shallow brass duplex extension head with insulating bushing, Harvey Hubbell Inc. #SC-3090.
- 3. Plug above floor outlets shall be equipped with a brass 2-1/8" flush cap and a

shallow brass extension with 2 back-to-back, 15 ampere, 125 volt, grounding type receptacles, Harvey Hubbell Inc. #SC- 3092.

4. Extension floor outlets shall be cast iron floor boxes with cast iron cover and 2" offset entry, for above-floor conduit extension; Harvey Hubbell #F3186. Boxes shall be designed to permit access to wiring without disturbing above-floor extension, and shall be set flush with finish floor.
5. Above floor service fitting for surge suppression receptacles shall be equal to Hubbell Cat. No. SC3098 with cover plate SS309DS.
6. Above floor service fittings for future computer networking shall be equal to Hubbell Cat. No. SC3098 with cover plate SS309B.

D. Floor Pockets:

1. Three-Gang: Three-gang floor lighting pockets shall be flush floor type, with cast iron floor plate and hinged cast iron door notched for cables. Three-gang floor pockets shall be C.W. Cole TLS-353- 6 for wood floors and C.W. Cole TLS-353-6-C for concrete slabs. Each floor pocket shall contain three 20 ampere, 3 wire, 125 volt receptacles with matching caps.
2. Single Gang:
  - a. Receptacle floor pockets shall be single gang, flush floor type, with cast iron floor plate, hinged cast iron door notched for cable and cast iron box; Cole #TLA-362-1-FE. Equip each pocket with a standard single grounding type receptacle unless otherwise indicated. Use C.W. Cole #TLS-362-1, in wood floors.
  - b. Microphone or projector floor pockets shall be single gang flush floor type with cast iron floor plate, hinged cast iron door, notched for cable and cast iron box, C.W. Cole #TLA- 362-3-FE. Use C.W. Cole #TLS-362-3, in wood floors.

E. Keys and Locks:

1. Contractor shall provide 2 keys with each door lock furnished, including cabinet door locks, switchboard locks, etc.; and shall provide 2 keys for each lock switch on a switchboard or control panel; and shall provide 2 keys with each interlock or other lock switch furnished. Deliver keys to the District's Inspector. Unless otherwise specified, keys shall be Corbin 60.
2. Locks shall be keyed to a Corbin 60 key for access to operate equipment and Corbin 70 key for service access. Special keys and locks shall be provided where specified.

## 2.02 RECEPTACLES AND SWITCHES

A. Receptacles:

1. Duplex receptacles with more than one (1) duplex connected to circuit breakers shall be specification grade, 15 amperes, 125 volts, 3 wire, side wired with binding screws, parallel slots, U-ground, plaster ears and captive mounting screws. Body shall be phenolic, plastic or bakelite. Receptacles shall be heavy duty, 3 blade current carrying contacts and double wide flat blade ground contacts. Receptacles shall be Hubbell, Leviton or approved equal, color shall be per Architect.

2. Duplex receptacles shall be specification grade, grounding type, side wired, with binding screws, receptacles shall have standard size ivory bakelite base. For circuits consisting of one single duplex receptacle only, ampere rating of receptacle shall be the same as circuit breaker or fuse. 15 ampere, 125 volt receptacles shall be NEMA 5-15R, Arrow-Hart. 20 ampere, 125 volt receptacles shall be NEMA 5-20R, Arrow-Hart, color shall be per Architect.
3. Ground fault interrupter type receptacles shall consist of a single receptacle and reset device manufactured in a standard configuration for use with a duplex plate. Receptacles shall be feed-thru, 20 ampere, NEMA 5-20R, white in color and shall be Leviton 6399-I, or equal. Exterior mounted receptacles shall be weatherproof.
4. Weatherproof receptacles shall, except where otherwise indicated or specified, consist of a duplex receptacle as specified herein and a metal plate with die cast hinged lid and weatherproof mat, Arrow-Hart #5252-WP. Weatherproof receptacle shall have a taylor #20510 cover only.

B. Switches:

1. Local Switches:

- a. Local switches shall be tumbler type, specification grade, rated 20 amperes at 120- 277 volts AC only, with plaster ears, binding screws for side wiring, and standard size composition cups which fully enclose the mechanism. Switches shall be approved for use at currents up to the full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80% of the rating for motor loads. Switches shall be single pole, double pole, 3-way, 4-way, non-lock type. Non-lock type switches shall have ivory handles, and switch shall be Hubbell 1221-I single pole, 1222-I double pole, 1223-I 3-way, and 1224-I 4-way. Color shall be per Architect.
- b. All lock type switches shall have metal or nylon key guides with ON/OFF indication, and shall be operable by the same key. Keys for lock type switches shall be forked type, cut from 1/16" stock. Fork dimensions shall be: External 1/4", Internal 5/32", depth 3/16" and radius 5/64". Key switches shall be Hubbell 1221-L single pole, 1222-L double pole, 1223-L three-way, and 1224-L four-way or approved equal. Where pilot light is required for key switch see paragraph on "Pilot Lights". Color shall be per Architect.
- c. Remote control switches for mechanically held contactors arranged for 3-wire control shall be tumbler type, momentary contact, single pole, 3-position with center "OFF", rated 20 amperes at 120-277 volts AC only, with plaster ears, binding screws for side wiring, standard size composition cups which fully enclose mechanism, and ivory handles; Hubbell 1556-I.

2. Time Switches and Photo Electric Controls:

- a. Time switches shall be 7 day solid state electronic type, capable of fully automatic or manual operation, and shall be housed in a sheet steel enclosure unless built into a panel or switchboard. Contacts shall be rated for 25 amps resistive or inductive-each pole, 240 Vac, 5 amp tungsten or 470 Vamp pilot duty- each pole 240 Vac. Time switches shall have a non-volatile clock and non-volatile memory and it shall have a built-in rechargeable power carry-over system. Switch shall have a minimum of 15 on/off set points per week. Timing shall be in one minute

increments with a minimum on or off time of one minute. Time switch digital display shall show days of week, hour and minute. Display shall have a load status light to indicate when equipment is in operation. Time switch shall be equal to EZ Controls Model EZ-701-1, single pole or Model EZ-701-2, double pole.

- b. For outdoor lighting control, time switches shall be digital with astronomic capabilities. Time switches shall have 365 day with holiday capabilities with 16 single dates and 5 holiday blocks of unlimited duration utilizing 8th and 9th day schedules. Time switch shall have 2 separately controllable relay closure output circuits. Each circuit shall be single pole, double throw, with contacts rating of 10 amp. resistive at 120/250 Vac and 7.5 amp inductive at 120/2500 Vac. Time switch shall have 48 events per circuit per week; separate scheduling for each day of week. Time switch shall have user selectable daylight saving or standard time, automatic leap year correction, and 72 hour memory backup with rechargeable battery. Time switch shall be equal to Tork Series DZS-200.
- c. Where more than 2 timed circuits are required, time switch shall be equal to Tork K Series, digital, 4, 6 or 8 circuits, with following features:
  - 1) Liquid Crystal Display Panel.
  - 2) Holiday Scheduling: Up to 40 dates may be assigned special holiday schedules, up to one year in advance.
  - 3) Automatically adjusts to and from daylight savings time and for leap year.
  - 4) Contact Ratings: 10 amp at 240 Vac.
  - 5) Safety override switch for each circuit to provide shut down of circuit, or override ON.
  - 6) Selective Review: All or part of schedule shall be displayed at touch of a key.
  - 7) Battery backup for up to one year.
  - 8) Supply Voltage: 120V.
  - 9) 365 Day Advance Scheduling.
- d. Photoelectric Control: Photoelectric control shall be rated 2000 watts, 120V with single pole, single throw, normally closed contact, enclosed in a die-cast aluminum gasketed enclosure with 2" conduit fitting, equal to Tork Series 2100.

## 2.03 IDENTIFICATION AND SIGNS

### A. Name Plates:

- 1. Following equipment shall be provided with name plates unless otherwise specified: switchboards, motor control centers, control panels, push button stations, time switches, contactors, motor starters, motor switches, lighting panelboards, power panelboards, and terminal cabinets.

2. Following devices shall be provided with circuit call out engraved in plate of device, receptacles and switches.
3. Name plates shall adequately describe function, voltage and phase of particular equipment involved. Where name plates are detailed or described on Drawings, inscription and size of letters shall be as indicated. For lighting and power panels, name plates shall indicate panel designation, voltage and phase of panel. For terminal cabinets, name plates shall indicate system housed therein.
4. Name plates shall be black and white nameplate stock of bakelite with characters cut through black exposing white. Plates shall have beveled edges and shall be securely fastened in place with #4 Phillips head, cadmium plated steel, self-tapping screws. Characters shall be 3/16" high, unless otherwise indicated.

B. Markings:

1. Following equipment and controls shall have markings:
  - a. Surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and appliances. Abbreviations acceptable to the District's Electrical Inspector, along with an identifying number, shall be used. Markings shall be done with locking type stencils using paint of a contrasting color. Figures shall be 3/8" high unless otherwise indicated. Dymo Industries, Inc., self-sticking plastic labels, having embossed characters made with a typewriter, may be used, in lieu of stencils and paint.
2. High Voltage: High voltage switchboards, cabinets, boxes, and conduits exposed in accessible locations, including under buildings and in attics, shall be marked "DANGER-HIGH VOLTAGE". Markings for switchboards shall consist of an #18 gage steel, porcelain enamel sign, of standard manufacture. Markings for boxes, cabinets and conduits shall be by means of stenciling or printed self-adhesive markers, Westline "Tel-A-Pipe". Letters shall be black on orange background and not less than 1-7/8" high. On conduit runs, marking shall be applied at intervals not exceeding 10' in any individual area. Markings shall be done only after other painting has been completed.
3. Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each per.
4. Where a building or structure has any combination of branch circuits, feeders, or services passing through it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location denoting all other services, feeders, and branch circuits passing through that building or structure and the area served by each.

C. Warning Signs:

1. Provide a warning sign on outside of each door or gate to rooms or enclosures containing high voltage equipment. Signs shall read: "DANGER- HIGH VOLTAGE-KEEP OUT". Signs shall be 7" x 14" with all lettering 1" high except word "DANGER" which shall have 1-1/2" high letters.
2. Provide a warning sign on each high voltage non-load break disconnect and fused cutout (not oil filled). Signs shall read: "DO NOT OPEN

UNDER LOAD". Lettering shall be 1" high.

3. Signs shall be of standard manufacture #18 gage steel, with porcelain enamel finish. Letters shall be red on white background.

## PART 3 - EXECUTION

### 3.01 BOXES; INSTALLATION AND SUPPORT

- A. Outlet boxes shall be flush with finished surface of wall or ceiling. They shall be plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, factory-made bar hangers shall be used to support outlet boxes.
- B. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels, shall be supported, except where otherwise indicated, by a Unistrut #P-4000 channel spanning main ceiling runner channels. Each box shall be supported from its channel by a 3/8" 16 threaded steel rod with a Unistrut #P-4008 nut and a Tomic #711-B Adapta-Stud. Rod shall be tightened to a jamb fit with channel and its nut. Box shall be locked to the rod by means of a 2" locknut on stud and a 3/8" 16 hex nut locking stud to rod.
- C. Heights of outlets and equipment indicated on Drawings shall govern, but absence of such indications, following heights shall be maintained, (Heights are to centerline unless otherwise noted):
  1. Return-call buzzer, communication switch, pushbutton, interphone, light switch, other switches, and fire station outlets: 48".
  2. Bell outlets in corridors: 12" below ceiling.
  3. Clock, speaker, and bell outlets in classrooms and offices: 8'-0".
  4. Outside bell and yard light outlets: 4'-0" above second floor level for 2 or more story buildings, 12" below top plate level for one story buildings without covered porch or arcade, and 12" below covered porch and arcade ceilings.
  5. Desk public telephone, desk interphones, and receptacle outlets 18".
  6. Panelboards and terminal cabinets: 6'-6" to top.
  7. Television outlets shall be located at a height corresponding to location of TV monitor.
- D. Receptacle outlet boxes shall not be located within 6'-0" of classroom water sinks, except in science laboratory classrooms where a ground fault interrupter circuit-breaker shall be provided to protect receptacle outlets located within 6'-0" of water sinks.

### 3.02 PLATES

- A. Provide a plate on each new switch, plug, pilot light, buzzer, interphone, public telephone, and television outlet, and on existing and reset outlets where so indicated. Plates shall be of stainless steel unless otherwise specified. Public telephone, interphone and buzzer outlet plates shall have single bushed openings. Sectional plates will not be accepted.
- B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with blank stainless steel plates. Flush lighting outlets to be capped shall be covered with Wiremold # 5736 steel covers, painted to match the surrounding finish. Surface-mounted outlets indicated to be capped shall be covered with blank stainless steel covers.



- C. Switch and receptacle plates shall be provided with engraved designations under any one of following:
1. Three gang and larger gang switches.
  2. Lock switches.
  3. Switches so located that operator cannot see one of the fixtures or items for equipment controlled with his hand on the switch.
  4. Switches not in same room with fixtures or items of all unit heaters, air curtains, fly fans, exhaust fans, and GTC.
  5. Receptacles operating at other than 120 volts.
  6. Where so indicated on Drawings.
  7. Switches operating on 277 volts.
- D. Designations shall be as indicated on Drawings or as specified and shall be engraved in plates with 3/16" high block type letters filled with black enamel. Where designations are not indicated or specified they will be given after Contract is awarded. For estimating purposes, they may be assumed not to exceed more than 10 letters per gang.

### 3.03 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Switchboards, motor control centers, transformers, panelboards, circuit breakers, disconnecting switches, starters, pushbutton control stations and other apparatus used for operation or control of circuits, appliances or equipment, shall be properly identified by means of descriptive nameplates or tags permanently attached to apparatus or wiring.
- B. Nameplates shall be engraved laminated bakelite or etched metal. Shop drawings with dimensions and format shall be submitted to the Architect before installation. Attachment to equipment shall be with escutcheon pins, rivets, self-tapping screws or machine screws. Self-adhering or adhesive backed nameplates are not acceptable.
- C. Tags shall be attached to feeder wiring in conduits at every point where runs are broken or terminated, and shall include pull wires in empty conduits. Circuit, phase and function shall be indicated. Branch circuits shall be tagged in panelboards and motor control centers. Tags may be made of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.
- D. Cardholders and cards shall be provided for circuit identification in panelboards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit, area, and connected load.
- E. Junction and pullboxes shall have covers stencilled with box number when indicated on Drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting with finish.
- F. Name as designated in part 2A shall be correctly engraved with a legend indicating function or areas, when required by Codes, or indicated on Drawings.

END OF SECTION

## SECTION 16111

### CONDUIT AND WIRE

#### PART 1 - GENERAL

##### 1.01 SCOPE

A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:

1. Examine all other sections for work related to those other sections and required to be included as work under this section.
2. General provisions and requirements for electrical work.

##### 1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. Submit product data sheets for all wire, conduit, fittings and splicing materials.
- B. Submit material list for all conduit and fittings.

#### PART 2 - PRODUCTS

##### 2.01 CONDUIT

- A. Rigid steel conduit: Hot-dip galvanized, zinc coated. Threads shall be galvanized after fabrication.
- B. PVC coated rigid steel conduit: Hot-dipped galvanized after fabrication, with bonded 20 mil coating of polyvinyl chloride.
- C. Electrical metallic tubing: Galvanized. Couplings and connectors, seamless steel construction and of the water-tight compression type with insulated throat, Thomas & Betts Co. #5123 Series or approved equal.
- D. Flexible conduit: Galvanized steel. Connector shall be Thomas & Betts Co. #3312 and/or #3332 Series, complete with insulated throat, or approved equal.
- E. Liquid-tight flexible conduit: Sealitite Type U.A. with Appleton Series "ST" connectors.
- F. Nonmetallic conduit: Polyvinyl chloride, Schedule 40 or type "EB" (concrete encased).

##### 2.02 WIRE AND CABLE

- A. All wire and cable shall be copper, 600 volt, #12 AWG minimum unless specifically noted otherwise on the drawings. Conductors #10 AWG and smaller shall be solid. Conductors #8 AWG and larger shall be stranded. Type of insulation as noted on drawings and as follows:
  1. Type THHN/THWN insulation used for #4 AWG and smaller.
  2. Type THW or THHN/THWN insulation used for #2 AWG and larger.
  3. Type THW used for all panel feeders and service conductors.

4. Type THHN insulation used for circuit conductors installed in fluorescent lighting fixture raceways, for conductors connected to the secondary of fluorescent or mercury vapor fixture ballast or other hot locations.
5. Type XHHW or THWN insulation shall be used where conductors are installed in conduit exposed to the weather.
6. The following color code for branch circuits:

Neutral . . . . White (Tape feeder neutrals with white tape near connections)

a. Normal Power

120/240 Volt

Ground . . . . Green  
Phase A . . . . Black  
Phase B . . . . Red  
Phase C . . . . Blue

480/277 Volt

Ground . . . . Green  
Phase A . . . . Brown  
Phase B . . . . Orange  
Phase C . . . . Yellow

b. Emergency power same insulation color as normal power except as follows:

120/208 Volt

Provide a continuous color stripe on each conductor insulation, orange or yellow except ground

480/277 Volt

Provide a continuous stripe on each conductor insulation blue or black except ground.

7. Feeders identified as to phase or leg in each panelboard with printed identifying tape.
8. Fire alarm conductors: Use 600-volt, type THHN/THWN conductors and color-coded per equipment manufacturer's recommendations.
9. Panel feeders copper or aluminum: Wire size shown on the drawings is for copper: if aluminum wire is proposed, increase wire size to ampere capacity of copper wire and voltage drop not to exceed that of copper feeders indicated on drawings. Increase conduit size and quantity as required by code.
10. Color coding for mechanical and plumbing control wiring shall be an agreed upon color code between the Mechanical/Plumbing Contractor and the Electrical Contractor, and color code shall be submitted to the Architect in writing for approval prior to installation.

### PART 3 - EXECUTION

#### 3.01 TRENCHING, FOOTINGS, SLEEVES

- A. Provide trenching, concrete encasement of conduits, back filling, and compaction for the underground electrical work, in accordance with applicable sections of this specification.
- B. Provide footings for all post and/or pole-mounted lighting fixtures: concrete shall conform to the applicable sections of this specification.
- C. Sleeves
  1. Provide sleeves for raceways and conduit passing through the following construction elements:
    - a. Concrete foundations, floors, walls and slabs.

- b. Lath and plaster walls and ceilings.
- 2. Sleeves shall extend 12 inches above floors, except under floor standing electrical equipment. Sleeves shall be flush with walls, ceilings, foundations and partitions. Sleeves shall be installed at exact penetration locations and angles to accommodate raceway and conduit routings.
- 3. Joists, girders, beams, columns or reinforcing steel shall not be cut or weakened. Where construction necessitates the routing of conduit or raceways through structural members, framing or under footings, written permission to make such installation shall first be obtained from the Architect. Such permission will not be granted, however, if any other method of installation is possible.
- 4. The layout and design of raceways and conduits located in or routed through masonry or reinforced beams or walls shall be reviewed by the Architect before any work is performed. All sleeving shall be accomplished according to the instructions of the Architect and shall be accepted before any concrete is poured.
- 5. Sleeves, raceways and conduit shall be located to clear steel reinforcing bars in beams. Reinforcing bars in walls shall be offset to clear piping and sleeves.
- 6. Provide 2" continuous clearance between inside of sleeve and exterior of conduits and raceways passing through the sleeve, unless otherwise specified. Where sleeves pass through outside walls below grade, provide full 1" clearance between exterior of conduits and raceways passing through the sleeve. For seismic joints, clearance shall be 3".
- 7. Sleeves set in fire walls shall be caulked between sleeve, conduit and raceways passing through the sleeve with fireproof sealant.
- 8. Sleeve Material:
  - a. In floor slab construction: Schedule 40 black steel pipe, with upper surface to be sealed watertight.
  - b. In concrete walls: Schedule 40 black steel pipe. When installed in outside walls, seal outer surface watertight.
  - c. In lath and plaster partitions and ceiling: 24 gauge galvanized iron or steel.
  - d. Sleeves through waterproof membranes: Cast iron or Schedule 40 steel with flashing clamp device and corrosion resistant clamping bolts. Caulk space between pipe and sleeve with outer surface sealed watertight.

### 3.02 GROUNDING

- A. Grounding shall be executed in accordance with all applicable codes and regulations, both of the State of California and local authorities having jurisdiction.
- B. Where nonmetallic conduit is used in the underground distribution system, the Contractor shall install the proper sized copper ground wire in the conduit with the feeder for use as an equipment ground. The electrical metallic raceway system shall be grounded to this ground wire.
- C. The maximum resistance to ground shall not exceed 5 ohms.
- D. Where an equipment bonding ground wire is installed or where nonmetallic or flexible conduit is used for feeder, subfeeder or branch circuit wiring, a green insulated, copper ground wire, sized in accordance with the following table, shall be installed. Install ground wire in each conduit with phase conductors.

Feeder, Subfeeders & Branch Circuit Protection	Minimum Ground Wire Size
15 Amp	#12
20 Amp	#12
30 to 60 Amp	#10
70 to 100 Amp	#8
101 to 200 Amp	#6
201 to 400 Amp	#3
401 to 600 Amp	#1
601 to 800 Amp	1/0
801 to 1000 Amp	2/0
1001 to 1200 Amp	3/0
1201 to 1600 Amp	4/0
1601 to 2000 Amp	250 MCM
2002 to 2500 Amp	350 MCM
2501 to 4000 Amp	500 MCM

- E. Where conductors are run in parallel in multiple raceways, the grounding conductor shall be run in parallel. Each parallel equipment grounding conductor shall be sized on the basis of the ampere rating of the over current device protecting the circuit conductors in the raceway. When conductors are adjusted in size to compensate for voltage drop, grounding conductors, where required, shall be adjusted proportionately in size.
- F. Ground conductors for branch circuit wiring shall be attached to each outlet to the back of the box using drilled and tapped holes and washer head screws, 6-32 or larger.
- G. Each panelboard, switchboard, pull box or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

### 3.03 CONDUIT

- A. The sizes of the conduits for the various circuits shall be as indicated on the drawings and as required by code for the size and number of conductors to be pulled therein. Conduits to be concealed except as noted otherwise.
  - B. Rigid steel conduit shall be used in the following areas:
    - 1. Embedded in concrete.
    - 2. Embedded in brick or masonry walls.
    - 3. Exposed on interior of buildings below eight feet.
    - 4. Exposed on exterior of building.
    - 5. Damp or wet locations.
- Rigid steel conduit shall not be installed in direct contact with earth or sand.
- C. PVC-coated rigid steel conduit shall be used for all elbows and risers, for underground nonmetallic conduits, and for all underground microphone, speaker and dimming control circuit conduits.
  - D. Electrical metallic tubing up to and including 4 inch may be installed as permitted by codes referenced within specifications.
  - E. Flexible steel conduit may be used for equipment and transformer connections only.

- F. Liquid-tight flexible conduit shall be used for final connection to motors, control devices mounted on vibrating or rotating equipment, equipment indicated on drawings to have flexible conduit connections, and in all areas where exposed flexible connections are required.
- G. Nonmetallic conduit shall be used for all underground runs unless specifically noted or specified otherwise. Provide PVC-coated steel conduit for all elbows and risers. Nonmetallic conduit shall not be run in slabs or walls, above ceiling or exposed.
- H. Conduit Installation:
1. Conduits shall be supported and braced per OSHPD Anchorage pre-approval No. R-0010 the SMACNA "guidelines for seismic restraints for mechanical systems and plumbing piping systems" or OSHPD Anchorages pre-approval No. R-003 the Superstrut Seismic Restraint System for pipes and conduits only.
  2. Securely and rigidly support all conduits from building structure. Provide supports maximum of ten feet on centers and within three feet of all bends, outlets, junction boxes, cabinets, panels and fittings. Conduits shall be supported independent of all piping, duct work, equipment ceiling hanger wires, and suspended ceiling grid systems. All conduits shall be secured by means of approved pipe clamps or straps. The use of "plumbers tape" is prohibited.
  3. Individual conduits suspended above ceiling shall be supported by means of hanger rods and pipe clamps. Multiple conduits suspended above ceilings shall be supported by means of trapeze type hangers and pipe clamps.
  4. Individual conduits placed against brick, masonry or concrete walls or slabs shall be secured with pipe clamps and expansion shields. Individual conduits placed against dry wall or plaster construction shall be secured by means of pipe clamps and screws attached to studs or other structural members. The use of toggle bolts is prohibited. Provide preformed channel supports for all multiple conduits placed against walls or slabs.
  5. Unless otherwise restricted by structural drawings as specifications the maximum size conduit permitted in concrete slabs or walls shall be not be greater than 1/4 of the slab thickness. Conduits installed in concrete slabs shall not cross.
  6. Conduit below slab on grade or underground exterior to building shall be spaced a minimum of 3" between identical systems and 12" between power and all other systems except at termination points.
  7. Conduits which are installed at this time and left empty for future use shall have polyvinyl rope left in place for future use.
  8. Conduits stubbed outside of building line for future use shall be terminated a minimum of five feet clear of building or adjacent concrete walks or A.C. paving and capped and marked. Provide tag engraved with the number and size of conduits and type of service (i.e., "POWER", "TEL.", etc.).
  9. Provide expansion and deflection fittings, with bonding jumper at all building expansion or seismic joint crossings.
  10. Provide two locknuts and an insulated bushing at each metallic conduit terminating at outlet boxes, junction boxes, terminal cabinets, switchboards and panelboards. Provide insulated bushing at each metallic conduit stub-up location. Bushings shall have ground lugs when installed on a metallic extension of PVC conduit run.
  11. Provide metallic or plastic caps on all conduit during construction until installation of conductors.

12. Branch circuit and telephone conduits turned up from floor into interior demountable partitions or to equipment not adjacent to all wall shall terminate in flush coupling at floor and then extend into partition or to equipment. Refer to architectural drawings for location of demountable partitions.
13. Conduit run exposed shall be run at right angles or parallel to the walls or structures. All changes in directions, either horizontally or vertically, shall be made with conduit outlet bodies as manufactured by Crouse Hinds or equal. Conduits run on exposed beams or trellis work shall be painted to match surrounding surfaces. Conduits run exposed on roofs shall be installed on 2x4 redwood sleepers, maximum 5 foot on centers. Sleepers shall be set in nonhardening mastic.
14. Rigid steel conduit or electrical metallic tubing shall not be strapped or fastened to equipment subject to vibration or mounted on shock absorbing bases.
15. From each panel which is flush mounted in a wall, stub up from top of the panel a minimum of four 3/4" conduits to the nearest ceiling spaces or other accessible location and cap for future use.
16. Conduit rising from floor for motor connection independently supported if over 24" above floor. Support shall not be to a motor or duct work which may transmit vibrations.
17. All conduits, except for 120 or 277 volt branch circuits and communication conduits, which are run exterior to building slab shall be concrete encased. If PVC type EB conduit is used it shall be concrete encased the full length of the conduit installation including under building slab.
18. Concrete for encasement of nonmetallic conduits shall be red 200E PSI with a maximum of 3/4" gravel. Provide prefabricated plastic spacers between each conduit. Provide a minimum of 2" of concrete between each conduit and a minimum of 3" of concrete on top, bottom and side of duct bank. Provide a minimum of 12" of concrete over power and signal system conduits. Provide ten pounds of red coloring cement for each cubic yard of concrete.
19. Provide all trenching, excavation, shoring and backfilling required for the proper installation of underground conduits. Bottoms of trenches to be cut to grade. Make trenches 12 inches wider than the greatest diameter on the conduit. All conduits exterior to building slab shall be set on a 6 inch bed of damp sand, and backfilled to within 12 inches of finished grade with damp sand. Remainder of backfill to be native soil. Soil shall have no stones or aggregate greater than 3". Do not backfill until installation has been approved and as-built drawings are up to date. Promptly install all conduits after excavation has been done, so as to keep the excavations open as short a time as possible. All excess soil from trenching shall be removed from the site.
20. Install underground conduit, except under buildings, not less than 24" below finished grade in nontraffic areas and 30" below finished grade in traffic areas, including roads and parking areas. Install long radius bends in all underground conduits in excess of 100 feet long.

### 3.04 WIRE AND CABLE

- A. Branch circuit and fixture joints for #10 AWG and smaller wire shall be made with UL-approved connectors listed for 600 volts, approved for use with copper and/or aluminum wire. Connector to consist of cone-shaped, expandable coil spring insert, insulated with a nylon shell and 2 wings placed opposite each other to serve as a built-in wrench or shall be molded one-piece as manufactured by "Scotchlok".

- B. Branch circuit joints of #8 AWG and larger shall be made with screw pressure connectors made of high strength structural aluminum alloy and UL-approved for use with both copper and/or aluminum wire as manufactured by Thomas & Betts. Joints shall be insulated with plastic splicing tape, half-lapped and at least the thickness equivalent to the conductor insulation. Tapes shall be fresh and of quality equal to Scotch.
- C. Use U.L. listed pulling compound for installation of conductors in conduits.
- D. Correspond each circuit to the branch number indicated on the panel schedule shown on the drawings except where departures are approved by the Architect or the Owner's inspectors.
- E. All wiring, including low voltage, shall be installed in conduit.
- F. Control wiring to conform to the wiring diagrams shown on the mechanical drawings and the manufacturer's wiring diagrams.
- G. All splices in exterior pull boxes and light poles shall be cast resin encapsulated.
  - 1. Power conductor splices - 3M Scotchcast Series 82/85/90; Plymouth or equal.
  - 2. Control and signal circuits 3M Scotchcast series 8981 thru 8986, Plymouth or equal.
- H. Neatly group and lace all wiring in panelboards, motor control centers and terminal cabinets with plastic ties at 3" on centers. Tag all spare conductors.

END OF SECTION



## SECTION 16115

### MANHOLES AND PULLBOXES

#### PART 1 - GENERAL

##### 1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
  - 1. Examine all other sections for work related to those other sections and required to be included as work under this section.
  - 2. General provisions and requirements for electrical work.

##### 1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. Submit product data sheets for all racks, hooks, supports, ladders, covers grounding, manholes, vaults, pullboxes, joint sealing compound, etc.
- B. Submit detailed shop drawings including dimensioned plans, elevations, details, structural calculations signed by a California State registered Structural Engineer and descriptive literature for all component parts.

#### PART 2 - PRODUCTS

##### 2.01 GENERAL

- A. Each concrete precast section shall be identified by having the manufacturers name and address cast into an interior face or permanently attached thereto. Associated Concrete Products-Quickset, Brooks Products or equal.
- B. Structure Construction
  - 1. The precast steel reinforced concrete structure walls, floor and roof shall safely sustain the loads and pressure resulting from vertical and lateral earth loadings and vehicular loadings. Based on the following criteria:
    - a. Minimum earth density shall be 120 lbs/cu. ft.
    - b. Minimum equivalent fluid pressure for lateral pressure due to earth shall be 85 lbs/ sq. ft. undrained earth conditions, minimum safety factor for buoyancy shall be 1.25.
    - c. Vehicular load rating shall be H-20 in compliance with latest AASHTO specifications.
    - d. Design shall be based on maximum depth of fill over the structure as indicated on the drawings.
    - e. Design and details shall comply with minimum ACI 318-63 code requirement. Minimum concrete 28 day cure strength shall be 3000 psi.
  - 2. Precast structure shall be designed to withstand forces due to additional inward load of 4,000 lbs. (working load) with safety factor of 2, acting perpendicular to the

surface at any pulling iron.

3. Structures shall be single piece or horizontal multi-section construction as required for field installation conditions. Multi-sections shall interlock with "Tongue and Groove" joint mating surfaces to insure a rigid assembly.
4. All structure precast joints shall be sealed with preformed cold field applied plastic joint sealing compound. Joint sealing compound shall not leak, sag or flow at the joints with 10 psi water pressure applied for 24 hours. Chemically resistant to acid, alkalies and saturated hydrogen sulfide.
5. Each precast structure section shall have suitable knockouts or opening in the vertical walls for the duct banks and conduits entering the structure. Provide a 1" diameter knockout in each corner of the floor slab, 6" from adjacent walls, for installation of ground rods.

## 2.02 MANHOLES

- A. The precast concrete roof of each manhole shall be provided with a 36" minimum diameter opening, and shall be equipped with necking ring suitable for installation of cover assembly. Provide precast concrete manhole grade ring(s) to bring the top of the cover to required elevation. Concrete grade ring(s) shall be of sufficient height to provide 12" minimum finish earth cover over top of manhole roof. Rings shall be tongue and groove mating surfaces to insure rigid assembly.
- B. A precast concrete grade ring cone shall set on top of the grade ring(s) to support the cast iron cover ring.
- C. Ladders shall be hot dip galvanized steel length as required for manhole depth. Cast iron, ladder swing joint retaining hook and grade ring steps shall be provided in the manhole necking grade rings. Provide a ladder for each manhole.
- D. Manhole sizes shall be as indicated on drawings. Dimensions are inside clear, but in no case shall the manhole inside height floor to ceiling be less than 7'-0" and minimum length and width shall not be less than 6'-0" x 8'-0".

## 2.03 PULLBOXES

- A. Pullboxes shall have deep recess conduit knockout concrete extensions at two opposite end walls. Additional shallow recess knockouts shall be provided on the other two walls for conduit entrances.
- B. Pullboxes shall be provided with a minimum of one precast concrete 6" extension grade ring "tongue and groove" mating surfaces to insure rigid assembly.
- C. Pullbox sizes shall be as indicated on drawings but in no case less than required by applicable codes. Minimum depth of the pullbox shall not be less than 42".
- D. The pullbox floor sump shall extend through the concrete floor into the gravel bedding, below the pullbox.

## 2.04 COVERS AND FRAME ASSEMBLIES

- A. Traffic rated per AASHTO for H20 loading.
- B. Manholes
  1. 30" diameter clear opening, flush fitting in cover frame ring.

2. Cover frame ring shall be cast iron and attach to the precast concrete grade ring cone with 2" diameter inserts and adjustable slotted head, threaded, stainless steel studs, minimum of four.
3. Provide two lifting "Eye" holes in cover.

C. Pull Boxes

1. Hot dip galvanized steel single piece flush fitting with threaded flush hold down, slotted head, stainless steel studs.
2. Topping frame shall be hot dip galvanized steel angle frame where the pullbox is installed in paving or concrete work.
3. Top ring frame shall be armor bank type where the pull box is installed in exposed earth or landscaping.

D. Covers shall be permanently marked in the cover metal as follows:

1. "E" or "Electric" for covers on structures containing power circuits under 600 volts and "HV" or "High voltage" for covers on structures containing power circuits over 600 volts.
2. "Signal" for covers containing signal circuits.

2.05 CABLE RACKS

- A. Cable racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.
- B. Vertical racks shall be installed on all walls of the structure a minimum of 24" on center within 6" of floor and top of wall. A rack shall be installed within 18" of each corner of each wall. Additional racks spaced equally on each wall shall be installed, spacing between vertical wall racks shall not exceed 24 inches.
  1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
  2. Hot dip galvanized, channel or T section steel.
  3. Racks shall be bolted to the precast structure walls.

2.06 PULL-IN-IRONS

- A. Pull-in-irons shall be galvanized steel bars bent in a "U" shape, and cast in the structure walls and floors.
- B. A floor pull-in-iron shall be centered under the manhole entry ring in the structure floor.
- C. Pull-in-irons shall not be less than 6 inches above or below, in the opposite wall from each knockout panel for conduit/duct entrances.
- D. Pull-in-irons shall project from the structure wall into the structure approximately four inches.

2.07 DRAINAGE SUMPS

- A. Provide drainage sump with cast iron metal grate in the floor of each structure. Minimum diameter of 12" by 4" deep. Provide a cast iron grate over the sump.

PART 3 - EXECUTION

### 3.01 EXCAVATION

- A. Excavate for installation of precast structures remove excess excavated material from the site. Saw cut existing paving and concrete as required for excavation.
- B. Provide a minimum of 6" deep bedding base of crushed rock 3/8" - 2" size in the bottom of the excavation. Bedding shall be level and well compacted by a minimum of four passes with a plate type mechanical vibrator.
- C. Back fill and compact earth around precast structure after installation of the structure to 90% minimum compaction in 12" lifts. Replace paving concrete, landscaping above structure to match existing.

### 3.02 INSTALLATION

- A. Install precast structures per manufacturers recommendations to provide a dry watertight installation. Set cover flush with existing grade or finish surface. Where precast structure is installed in pedestrian walkway or vehicular traffic way with a sloping finish grade. Slope cover to match existing finish surface slope.
- B. Install structures to avoid surface water drainage flow lines, and existing utilities.
- C. Exterior concrete walls tops and bases of precast structure shall be damp-proofed with two coats of a bituminous damp-proofing material, minimum finish thickness 4-mil.
- D. Connections to Precast Structure:
  - 1. Lines connecting to precast structures shall be constructed to have a cast in place concrete tapered section adjacent to the structure and extending a minimum of 48" out from the structure to provide shear strength.
  - 2. Precast structure shall be constructed to provide for keying the concrete envelope of the conduit/duct line into the wall of the structure. Mechanical vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the precast structure.
- E. Entrances of conduits/ducts shall terminate with endbells inside the precast structure.

### 3.03 GROUNDING

- A. Provide 10' long x 3/4" diameter copper clad, steel, driven grounds rods through the floor of the precast structure. Provide a minimum of two ground rods in opposite corners in manholes and vaults, one ground rod in pullboxes. Ground rod shall extend 6" above the floor line. Where rock bottom is encountered, bury ground rod in horizontal trench with projection into precast structure. Seal off openings around ground rods.
- B. Ground permanently and effectively together all metal equipment cases, cable racks, ladders, etc., with #4 bare copper bonding conductor. Provide U.L. compression bonding fittings at each ground connection.

END OF SECTION

SECTION 16141

MANUFACTURED WIRING SYSTEM

PART 1 - GENERAL

1.01 SCOPE

- A. Complete all work required by the drawings and as specified herein, including, but not limited to the following:
  - 1. Conversion Modules.
  - 2. Lighting Receptacle.
  - 3. Lighting Selector Module.
  - 4. Lighting Splicing Module.
  - 5. Switching Splicing Module.
  - 6. Switching Tee Module.
  - 7. Lighting Cable.
- B. Submittals: Submit product data sheets for all fittings, cables and devices.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. To convert wiring from conventional to manufactured wired system, 20 amp rated, voltage rating as required by circuiting.
- B. With 1, 2, 3 or 4 receptacles, as indicated by circuiting.
- C. Number 12 AWG copper leads.
- D. Suitable for installation in standard 4" stamped steel junction box.
- E. Provisions for indicating circuit designation.

2.02 LIGHTING RECEPTACLE

- A. Supply to lighting fixture manufacturer to installation by manufacturer on indicated fixture types.
- B. 20 ampere rated or required voltage.
- C. Maximum, four circuits per receptacle.
- D. Number 14 AWG copper leads.

2.03 LIGHTING SELECTOR MODULE

- A. For plug-in connection to lighting receptacle, permitting branch circuit wiring to be carried from fixture to fixture.
- B. 20 ampere rated or required voltage.

C. Maximum, four circuits per receptacle.

D. Similar relocate.

#### 2.04 LIGHTING SPLICING MODULE

A. To permit connection of adjoining cable sets.

B. 20 ampere rated of required voltage.

C. Maximum, four circuits per receptacle.

#### 2.05 SWITCHING SPLICING MODULE

A. Similar to Lighting Splicing Module to permit connection of adjoining switching cable sets.

#### 2.06 SWITCHING TEE MODULE

A. To permit connection of adjoining cable sets at the switch location.

B. 20 ampere rated of required voltage.

#### 2.07 LIGHTING CABLE SET

A. Flexible steel conduit, pre-wired with #12 AWG copper conductors, 600 volt, 90 degree C rated insulation and #12 AWG insulated copper ground conductor, terminated in keyed receptacles.

B. 20 ampere rated of required voltage.

C. Copper contacts with maximum four circuits per receptacle.

D. Number 16 gauge zinc plate receptacle housing.

E. Maximum length: 15 feet.

#### 2.08 SWITCHING CABLE SET

A. Similar to Lighting Cable Set except receptacle suitable for switching purposes of required length.

#### 2.09 ACCEPTABLE MANUFACTURER

A. Dual Lite Wiring Systems.

B. AFC Wiring Systems.

### PART 3 - EXECUTION

#### 3.01 WIRING INSTALLATION

A. Drawings indicate circuiting, switching arrangements and system components from the manufactured wiring system supplier for review by Engineer with all components.

B. Additional system components may be required. It is the responsibility of this supplier to become familiar with the intent of the plans and specifications and to include in his bid all costs for a complete system.

END OF SECTION

## SECTION 16142

### OCCUPANCY SENSOR AND DAYLIGHT MANAGEMENT

#### PART 1 – GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Digital Occupancy and Daylighting Sensor Control
2. Emergency Lighting Control (if applicable)

###### B. Related Section

1. Section 16050 – Basic Electrical Requirements
2. Section 16111 – Conduit and Wire
3. Section 16500 – Lighting Fixtures
4. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section
5. Electrical Sections, including wiring devices, apply to the work of this Section.

###### C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Task lighting and receptacle controls
5. Emergency Lighting control (if applicable)

##### 1.02 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- B. Underwriter Laboratories of Canada (ULC)
- C. International Electrotechnical Commission
- D. International Organization for Standardization (ISO)
- E. National Electrical Manufacturers Association (NEMA)
- F. WD1 (R2005) - General Color Requirements for Wiring Devices.

##### 1.03 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

1. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
2. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
3. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
4. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
5. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
6. Handheld remotes for personal control – One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
7. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
8. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS).
9. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
10. Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

#### 1.04 LIGHTING CONTROL APPLICATIONS

A. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual-ON functionality in all spaces. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
2. Bi-Level Lighting – Provide multi-level controls in all spaces as indicated on the drawings.



3. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
4. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.

#### 1.05 SUBMITTALS

- A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
- B. Shop Drawings:
  1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
  2. Scale drawing for each area showing exact location of each sensor, room controller, and digital switch.
- C. Product Data: Catalog sheets, specifications and installation instructions.
- D. Include data for each device which:
  1. Indicates where sensor is proposed to be installed.
  2. Prove that the sensor is suitable for the proposed application.

#### 1.06 QUALITY ASSURANCE

- A. Manufacturer: Minimum [10] years experience in manufacture of lighting controls.

#### 1.07 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
  1. Ambient temperature: 0° to 40° C (32° to 104° F).
  2. Relative humidity: Maximum 90 percent, non-condensing.

#### 1.08 WARRANTY

- A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

#### 1.09 MAINTENANCE

- A. Spare Parts:
  1. Provide 1 set of each product to be used for maintenance.

### PART 2 – PRODUCTS

#### 2.01 MANUFACTURERS

- A. Acceptable Manufacturer:

1. WattStopper
  - a. System: Digital Lighting Management (DLM)
2. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
  - a. WattStopper Digital Lighting Management (DLM)

B. Substitutions:

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.02 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

- A. Type PW: Manual-ON, Automatic-OFF passive infrared (PIR) wall switch occupancy sensor. Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper PW-100, PW-200, PW-103, PW-203.
- B. Type UW: Manual-ON, Automatic-OFF ultrasonic wall switch occupancy sensor with. Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper UW-100, UW-200.
- C. Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203.

2.03 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
  1. Digital calibration and pushbutton programming for the following variables:
    - a. Sensitivity – 0-100% in 10% increments
    - b. Time delay – 1-30 minutes in 1 minute increments
    - c. Test mode – Five second time delay

- d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
  - e. Walk-through mode
  - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
- 2. One or two RJ-45 port(s) for connection to DLM local network.
  - 3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
  - 4. Device Status LEDs including:
    - a. PIR Detection
    - b. Ultrasonic detection
    - c. Configuration mode
    - d. Load binding
  - 5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
  - 6. Manual override of controlled loads.
- C. Units shall not have any dip switches or potentiometers for field settings.
  - D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
  - E. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

## 2.04 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
  - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
  - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
  - 3. Red configuration LED on each switch that blinks to indicate data transmission.
  - 4. Blue Load/Scene Status LED on each switch button with the following characteristics:
    - a. Bi-level LED
    - b. Dim locator level indicates power to switch
    - c. Bright status level indicates that load or scene is active
  - 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

- B. Two RJ-45 ports for connection to DLM local network.
- C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
- D. The following switch attributes may be changed or selected using a wireless configuration tool:
  - 1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
  - 2. Individual button function may be configured to Toggle, On only or Off only.
  - 3. Individual scenes may be locked to prevent unauthorized change.
  - 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
  - 5. Ramp rate may be adjusted for each dimmer switch.
  - 6. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
- E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

## 2.05 HANDHELD REMOTE CONTROLS

- A. Battery-operated handheld switches in 1, 2 and 5 button configuration for remote switching or dimming control. Remote controls shall include the following features:
  - 1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.
  - 2. Blue LED on each button confirms button press.
  - 3. Load buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
  - 4. Inactivity timeout to save battery life.
- B. A wall mount holster and mounting hardware shall be included with each remote control
- C. WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105.

## 2.06 ROOM CONTROLLERS

- A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
  - 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
  3. Device Status LEDs to indicate:
    - a. Data transmission
    - b. Device has power
    - c. Status for each load
    - d. Configuration status
  4. Quick installation features including:
    - a. Standard junction box mounting
    - b. Quick low voltage connections using standard RJ-45 patch cable
  5. Plenum rated
  6. Manual override and LED indication for each load
  7. Dual voltage (120/277 VAC, 60 Hz)
  8. Zero cross circuitry for each load.
- B. On/Off Room Controllers shall include:
2. One or two relay configuration
  3. Efficient 150 mA switching power supply
  4. Three RJ-45 DLM local network ports
  5. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
    - a. One relay configuration only
    - b. Automatic-ON/OFF configuration
  6. WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101

## 2.07 DIGITAL PHOTOSENSORS

- A. Digital photosensors work with room controllers to provide automatic switching capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.
- B. Digital photosensors include the following features:
1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
  2. Sensor light level range shall be from 1-10,000 footcandles (fc).

3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling after they turn off.
5. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
6. Red configuration LED that blinks to indicate data transmission.
7. Blue status LED indicates test mode, override mode and load binding.
8. Recessed switch to turn controlled load(s) ON and OFF.
9. One RJ-45 port for connection to DLM local network.
10. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

C. Closed loop digital photosensors include the following additional features:

1. An internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes setpoints following self-calibration.
4. A sliding setpoint control algorithm for dimming daylight harvesting with a "Day Setpoint" and the "Night Setpoint" to prevent the lights from cycling.
5. WattStopper Product Number: LMLS-400.

D. Open loop digital photosensors include the following additional features:

1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
3. A proportional control algorithm for dimming daylight harvesting with a "Setpoint" to be maintained during operation.
4. WattStopper Product Number: LMLS-500.

## 2.08 ROOM NETWORK (DLM Local Network)

- A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices

connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:

1. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
3. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

## 2.09 CONFIGURATIONS TOOLS

- A. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include:
  1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
  2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
  3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
  4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
  5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
  6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.
- C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

## 2.10 NETWORK BRIDGE

- A. The network bridge connects a DLM local network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication.
  1. The network bridge may be incorporated directly into the room controller hardware (LMRC-3xx Room Controllers) or be provided as a separate module connected on the local network through an available RJ-45 port.

2. Provide Plug n' Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
3. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:
  - a. Read/write the normal or after hours schedule state for the room
  - b. Read the detection state of the occupancy sensor
  - c. Read/write the On/Off state of loads
  - d. Read/write the dimmed light level of loads
  - e. Read the button states of switches
  - f. Read total current in amps, and total power in watts through the room controller
  - g. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
  - h. Activate a preset scene for the room
  - i. Read/write daylight sensor fade time and day and night setpoints
  - j. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
  - k. Set daylight sensor operating mode
  - l. Read/write wall switch lock status

4. WattStopper product numbers: LMBC-300

## 2.11 SEGMENT MANAGER

- A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment networks as required and allow for control of a maximum of 127 local networks (rooms) and/or lighting control panels per segment network.
- B. Operational features of the Segment Manager shall include the following:
  1. Connection to PC or LAN via standard Ethernet TCP/IP.
  2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
  3. Log in security capable of restricting some users to view-only or other limited operations.
  4. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
  5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.



6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
7. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
8. Ability to group rooms and loads for common control by schedules, switches or network commands.
9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
10. Provide seamless integration with the BAS via BACnet IP

C. WattStopper Product Numbers: LMSM-201, LMSM-603.

## 2.12 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements
- B. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- C. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
  1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
- D. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
  1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
  2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
  3. Load Parameters (e.g. blink warning, etc.)

- E. Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

### 3.02 FACTORY COMMISSIONING .

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
- C. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

END OF SECTION

## SECTION 16160

### PANELBOARDS AND SIGNAL TERMINAL CABINETS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes: Lighting and power distribution facilities, including panelboards.

##### 1.02 SUBMITTALS

- A. Shop Drawings: Include a front elevation, indicate cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks.

##### 1.03 DESIGN REQUIREMENTS

- A. Lighting and Appliances Panelboards:

1. Lighting and appliance panelboards shall be wall-mounted, enclosed safety type with 277/480 volt, 4-wire or 120/208 volt, 4-wire solid neutral mains as indicated on Drawings or specified.
2. Single pole branches shall be molded case, thermal magnetic circuit breakers with inverse time delay, trip free, quick-make, quick-break mechanism and silver alloy contacts. Circuit breakers shall be rated as indicated on Drawings, with ampere rating marked on handle and shall indicate "ON - OFF" and tripped positions. Ground fault interrupters shall be incorporated into circuit breakers where indicated. They shall be listed by UL as a ground fault device.
3. Two and 3 pole branches shall be enclosed, and shall be thermal magnetic circuit breakers with inverse time delay, non-tamperable, ambient compensated, single handle, internal common trip, and quick-make, and quick-break mechanism with silver alloy contacts. Circuit breakers shall be rated as indicated on the Drawings.
4. Main and subfeeder circuit breakers shall be enclosed, thermal magnetic type with inverse time delay, single handle common trip, quick-make, quick-break mechanism, corrosion resistant bearings and silver alloy contacts. Ampere frame size and trip rating shall be as indicated on Drawings. Breakers over 225 amperes shall have interchangeable trip units. Handles of main and subfeeder circuit breakers shall be under cabinet door. Voltage rating shall be as indicated on Drawings.
5. All circuit breakers shall be one-piece, bolt-on type and shall meet short circuit interrupting capacity requirements indicated on Drawings, including series rating.
6. Breakers shall have a minimum short circuit interrupting rating of 10,000 symmetrical for panels board voltage 240 volts and 14,000 symmetrical thru 600 volts or as specified on drawings. Interrupting rating shall not be less than what is indicated on drawings.
7. All internal connections indicated of outdoor panelboards shall be made with plated copper bus bars and the busses shall extend for full length of space available for branch circuit breakers. All internal connections shall be made with plated aluminum bus bars for indoor panelboards. Feeder cable connectors shall be installed at point of feeder entrance. All terminals shall have copper conductors. Panelboards fed by conductors having overcurrent protection greater than 200 amperes shall be protected on supply side by overcurrent devices having a rating

not greater than that of panelboard.

8. Except where otherwise indicated, circuit breakers shall be in 2 vertical rows connected to bus bars in a distributed phase arrangement. Two pole branches shall be balanced on busses. Each single pole branch shall be numbered adjacent to its circuit breaker with odd numbers on left and even numbers on right.
  9. All specified circuit breaker spaces shall include necessary hardware required for future installation of circuit breakers.
  10. Provide locking devices for each individual circuit breaker. Padlocking device shall be secured to circuit breaker and by panel deadfront plate.
- B. Power Panelboards: Power panelboards shall conform to the Specifications for lighting and appliance panelboards, where applicable, except that mains shall be bussed 240 or 480 volts, 3 phase, or as required, and that branches shall be enclosed, quick-make, quick-break thermal-magnetic circuit breakers with inverse time delay trip, of frame size and trip rating indicated, and with corrosion-resistant bearings, silver alloy contacts and single handle, common trip, free operation. Breakers over 225 ampere size shall have interchangeable trip units. Main shall be as indicated on Drawings. All circuit breakers shall be one-piece, bolt-on type.
- C. Panelboard Cabinets:
1. Panelboard cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trims shall be code gauge furniture steel. Cabinets shall have at least 6" high gutters at top and bottom where feeder cable size exceeds #4 or where feeder cable passes through cabinet vertically. Cabinets shall have top and bottom gutters sized as required by inspection department having jurisdiction, but never less than 6" where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than 4" wide. Width of cabinets shall be 20", unless indicated different on Drawings.
  2. Where contactors, time switches, and control devices are specified or indicated to be installed within panelboard cabinets, a separate compartment and door shall be provided at top of cabinet for such devices. Door shall be sized as required to permit removal of contactor and other devices intact. Gutters shall be provided at sides and top of compartment.
- D. Panelboard Schedule: Contractor shall prepare a neatly typewritten schedule with number or name of room or area, or load served by each panelboard circuit. Room numbers or names used shall be determined at site and shall not necessarily be those used on Drawings. Schedule shall also indicate panel designation, voltage and phase, building and distribution panel or switchboard from which it is fed. Schedule shall be mounted in a frame under transparent plastic 1/32" thick on inside of each panelboard cabinet door.
- E. Panelboard Standards: All panelboards shall meet latest revisions of following standards:
1. National Electric Code, Article 384.
  2. UL 67, Panelboards.
  3. UL 50, Cabinets and Boxes.
  4. UL 943, GFCI.
  5. UL 489, Molded case circuit breakers.
  6. NEMA PBI.
  7. Federal Specifications W-P-115 and WC-375B.
  8. Panelboards must be UL labeled.
- F. Terminal Cabinets, Signal:

1. All signal terminal cabinets shall conform in every respect to the Specifications for panelboard cabinets, except as modified herein.
2. All terminal cabinets shall be flush type, with 2" trim or surface mounted type, as indicated on Drawings. All terminal cabinets shall have section. Cabinets shall be provided with barriers to separate each system. Sections over 24" in width shall be provided with double door and lock. Each terminal cabinet, or section of a terminal housing a separate system, shall measure 12" long x 18" high x 5-3/4" deep, unless otherwise indicated on Drawings. Trims for sectional cabinets shall be of one-piece construction.
3. All terminal cabinets shall be equipped with 3/4" thick plywood backboards within cabinets, and fastened in place with machine screws. Backboards shall be largest size cabinet and conduit terminations will permit.
4. Flush mounted terminal cabinets shall be finished as specified for flush mounted panelboard cabinets. Surface and semi-flush mounted terminal cabinets shall be finished as specified for surface mounted panelboard cabinets.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT

- A. Panelboards shall be manufactured by RSE Sierra, Square D, General Electric, or approved equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Fronts shall be flush or surface type, as required. Fronts shall be fastened to cabinets with 1/4" #20, nickel-plated oval-headed machine screws and cup washers. Sufficient screws shall be installed to prevent buckling or warping of cabinet front. Flush type fronts shall be aligned plumb and square and cabinet shall be drilled and tapped, at site, for cover screws, to accomplish this if necessary.
- B. All surfaces of flush mounted cabinets shall be galvanized. Fronts shall be given 2 coats of metal primer and shall not be installed on cabinets until after finish coats of paint have been applied to wall and cabinet fronts and are thoroughly dry. Screws and cup washers shall not be painted.
- C. All surfaces of surface mounted cabinets and fronts shall be given one coat of metal primer and a finish coat of baked-on gray enamel.
- D. Cabinets shall be rigidly supported in place, independent of conduits.
- E. On floor-standing units, provide 1" minimum grout to set and level cabinets.
- F. All equipment exposed to the weather shall be provided with NEMA 3R enclosures whether or not shown on the drawings. Equipment located in rooms, building cavities or closets without doors or protection from the weather shall be provided with NEMA 3R enclosures.

END OF SECTION

## SECTION 16250

### AUTOMATIC TRANSFER SWITCH

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section includes: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
  - 1. Examine all other sections for work related to those other sections and required to be included in work under this section.
  - 2. General provisions and requirements for electrical work.

##### 1.02 SUBMITTALS

- A. Submit product data sheets for all switches, relays, controllers, power supplies, cabinets, etc.
- B. Submit detailed shop drawings including dimensioned plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature for all component parts and cabinets.
- C. Submit worst case voltage drop calculations on control circuits.

##### 1.03 REFERENCES: MANUFACTURER: ASCO, Russell Electric or ONAN

#### PART 2 - PRODUCTS

##### 2.01 TRANSFER SWITCH EQUIPMENT

- A. Provide 4-pole automatic transfer and isolation bypass with amperage, voltage and withstand ratings as shown on the plans. The system shall be the product of one manufacturer. The system shall be listed to the latest requirements of U.L. Std. #1008 and rated for all classes of loads as manufactured by ASCO, Russell or Onan.

##### 2.02 CONSTRUCTION

- A. Electrical operation shall be accomplished by a momentary energized electrical operator mechanism which receives power from the source to which the load is being transferred. Fuse or thermal protection of the main operator is prohibited. The total operating transfer time shall not exceed one sixth of a second, unless otherwise specified. The switch shall be mechanically locked in both the normal and emergency position.
  - 1. Operation shall be double-throw whereby contacts move simultaneously. Electrical spacing shall be equal to or exceed those listed in table 22.1 of UL 1008. Main switch contacts shall be high-pressure silver alloy and shall have arc chutes of heat absorbing material and metal leaves for positive extinguishing of arcs. A permanently attached manual operating handle shall be provided. An overload or short circuit shall not cause the switch to go into a neutral position.
  - 2. Switches shown as four pole shall switch the neutral with fully rated neutral transfer contacts. Phase and neutral contacts shall be driven by one single main

electrical operator.

## 2.03 AUTOMATIC CONTROLS

- A. Controls shall be contained in one electronic package, separately mounted, with solid state sensing and timing functions, and shall provide the following operational characteristics:
1. Time delay on momentary dips in normal source (0.5-6.0 seconds), set at 1.0 seconds.
  2. Time delay on transfer to emergency for controlled loading of the generator (0-5 minutes), set at 0 minutes.
  3. Time delay on transfer to normal (0-30 minutes), factory set at 15 minutes.
  4. Switch to manually bypass time delay on retransfer.
  5. Time delay on engine shutdown after retransfer to normal (0-5 minutes), set at 5 minutes.
  6. Close differential voltage sensing of all normal source phases (pickup 85-100% of nominal and dropout 75-98% of pickup), set at 85% dropout and 95% pickup.
  7. Independent voltage (85-100% pick-up) and frequency (90-100% pick-up) sensing of the emergency source to prevent premature transfer, set to pickup at 90% voltage and 95% frequency.
  8. Test switch (load-no load transfer function shall be provided).
  9. Engine start contacts, 10 amp (1-N.C. & 1-N.O.).
  10. Pilot lights to indicate power source available.
  11. Pilot lights to indicate switch position.
  12. Auxiliary contacts, ( 1-closed on "N" and 1-closed on "E") rated 10 amps, 250 VAC.
  13. An in-phase monitor shall be provided to control transfer/retransfer operation between live sources so that closure on the alternate source will occur only when the two sources are approaching synchronism and at the instant when the two sources within plus/minus 60 electrical degrees, max. The monitor shall function over a frequency difference range of plus/minus 2 hertz min., with a maximum total transfer operating time of one-sixth of a second. In the event of abnormal frequency difference (in excess of plus/minus 2 hertz) and/or failure of the load carrying source, the monitor shall be automatically bypassed. The monitor shall not require interwiring with generator controls nor active control thereof.
  14. In lieu of item 13 (in-phase monitor), transfer switch shall be provided with adjustable time delay between the opening of closed contact and closing of the open contact (0.-7.5 seconds, set 1.0 second) allowing for motor and transformer loads to be re-energized after transfer with normal or below normal inrush current.
  15. Automatic engine generator exerciser to provide adjustable 30 minute to 60 minute duration generator start-run and stop sequence, one time per week.
  16. All time delay and sensing functions shall be readily field adjustable over the

ranges indicated and operate without drift over minus 40 degrees F to 122 degrees F. The logic panel shall be provided with isolation plug in wiring harness between control panel and main transfer panel.

## 2.04 BYPASS SWITCH

- A. Bypass isolation and transfer switch shall be in a factory assembly. Bypass switch shall be a manually operated switch, and have the same close and withstand ratings as the automatic transfer switch. Switches requiring electrical operation shall not be acceptable.
1. Drawout isolation mechanism shall provide closed door drawout operation for automatic transfer switch, by using permanently mounted, external handle for 3-position operation. Isolation contacts shall be long life, silver plated, and rated for continuous operation at rated current.
  2. In the NORMAL position, isolation contacts shall be fully engaged with control cable connected.
  3. In the TEST position, isolation contacts shall be open with control cable connected. This position shall allow operational testing of transfer switch and controls without disturbing the load.
  4. In the FULLY ISOLATED position, the transfer switch and control shall be completely isolated from all power sources. This position shall allow the door to be opened and the transfer switch to be removed on drawout rails for inspection and servicing. The removal shall not require disassembly or use of tools. Mechanisms that do not allow for drawout on rails for switch removal shall not be acceptable.
  5. Bypass switch shall provide manual bypass to either normal or emergency source by use of a permanently mounted external handle. Designs which bypass to only one source shall not be acceptable.
  6. Equipment shall provide manual non-load break bypass to the source the automatic transfer switch is connected. Equipment shall be capable of manual bypass to the opposite source the automatic transfer switch is connected without opening circuit protection devices.
  7. An interlock system shall assure a properly sequenced, safe, mechanically guided bypass action. The equipment shall utilize automatic, solenoid-activated mechanical stops to prevent dead source bypass.

## 2.05 ACCESSORIES

- A. Pilot lights shall indicate availability of normal and emergency power sources and automatic transfer switch position. A prominent and detailed instruction plate shall be furnished.

## 2.06 RATINGS

- A. Electrical and mechanical Performance: The system must comply with U.L. Std. 1008 and NEMA Std. ICS 2-447. In addition, the switch must meet or exceed the following requirements and if so requested, be verified by certified prototype test data:
1. Temperature Rise: Measurements shall be made after the overload and endurance test.
  2. Close and Withstand: U.L. listed to close and withstand the magnitude of fault current at the switch terminals when coordinated with respective line side



protective devices as shown on the plans at X/R ratio of 6.6 or less.

3. Dielectric: Tested after the withstand test at 1960 VAC RMS minimum.
4. Voltage Surge: Control panel voltage surge withstand test per IEEE Std. 587-1980 and voltage impulse withstand test per ICS-1-109.

### PART 3 - EXECUTION

#### 3.01 SECTION INCLUDES

- A. The manufacturer shall certify that the complete unit meets or exceeds the seismic requirements of the California Administrative Code Titles 21 and 24.

#### 3.02 SECTION INCLUDES

- A. Certification: The manufacturer shall provide a notarized letter certifying compliance with all the requirements of this specification. The certification shall identify, by serial number(s), the equipment involved.

END OF SECTION

## SECTION 16450

### GROUNDING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

###### A. Work Included:

1. Provide and install a grounding system as specified and indicated.

###### B. Related Work:

1. See related sections for their system grounding requirements.
2. Section 16010: Basic Electrical Requirements.

##### 1.02 SYSTEM REQUIREMENT

###### A. Grounding shall be as approved by the State of California, Division of Industrial Safety.

###### B. Electrical continuity to ground metal raceways and enclosures, isolated from the equipment ground by use of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of approved size within each raceway connected to the isolated metallic raceways, or enclosures at each end. Each flexible conduit over six feet in length shall be provided with a green insulated grounding conductor of approved size.

###### C. Cold water or other utility piping systems shall not be used as grounding electrodes, due to the District's use of insulating couplings and nonmetallic pipe in such installations. All grounding electrodes shall be "made electrodes" specified as follows:

1. Grounding electrodes as specified in Part 2 Paragraph 2.01 B of this specification.
2. Concrete enclosed electrode, which is made up of at least 20 feet of #4 AWG copper conductor, encased by at least 2 inches of concrete, located within or near the bottom of a concrete foundation, or footing, which is in direct contact with the earth.

###### D. Non-current-carrying metal parts of all high voltage equipment enclosure, signal and power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively grounded.

###### E. Metallic or semi-conducting shields, and lead sheaths of all cables operating at high voltage, shall be permanently and effectively grounded at each splice and termination.

###### F. The neutral of service conductors shall be grounded as follows:

1. The neutral shall be grounded at only one point within the schoolsite for that particular service. Preferable location of the grounding point shall be at the service switchboard, or main switch.
2. The equipment and conduit grounding conductors shall be bonded to that grounding point.

###### G. Other buildings:

1. If other buildings on the campus are served from a switchboard or panelboard in

another building, the power supply is classified as a feeder and not as a service.

2. The equipment grounding conductor is carried from the switchboard to each individual building. At the building, the grounding conductor is bonded with the power equipment enclosures, metal frames of building, etc., to the "made electrode" for that building.
3. The neutral of the feeder shall not be grounded.
- H. If there is a distribution transformer at a building, the secondary neutral conductor shall be grounded to the "made electrode" serving the building.
- I. Within every building the main switchboard or panel shall be bonded to a 1" or larger cold water line with a 1" conduit with one #6 wire. All metallic piping systems (gas, fire sprinkler, etc.) shall be bonded to the cold water line with 3/4" conduit with one #8 wire.

### 1.03 SUBMITTALS

- A. Submit a material list in accordance with Section 01300: Submittals.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Yard boxes shall be precast concrete and shall be approximately 14" wide, 19" long, and 12" deep (outside dimensions), or larger, if necessary to obtain the required clearances. Boxes shall be equipped with bolt-down, checkered, cast iron covers and a cast iron frame cast into the box. Yard boxes shall be Brooks 36 or approved equal.
- B. "Made" electrodes shall be approved copper-clad steel ground rods, minimum 3/4" diameter, 10'-0" long.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A.
  1. Grounding electrodes shall be located in the nearest usable planting area, where not otherwise indicated on the Drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, concrete yard box shall be 2" above planting surfaces.
  2. The grounding electrode may be installed in the power distribution underground hand-hole, if that hand-hole is no more than 20 feet from the building being served.
- B. If the concrete enclosed electrode is used, the grounding wire shall terminate to a suitable copper plate with grounding lugs.
- C. Grounding rods shall be driven to a depth of not less than 8'-0".
- D. Grounding electrodes shall have a resistance to ground of not more than 5 ohms.
- E. When using grounding rods, if the resistance to ground exceeds 5 ohms, two or more rods connected in parallel shall be provided to meet the grounding resistance requirement.
- F. The minimum number of ground rods shall be as required by state electrical safety orders.

- G. Ground rods shall be separated from one another by not less than 6'-0
- H. Parallel grounding rods shall be connected together with approved fittings and approved grounding conductors in galvanized rigid steel conduit, buried not less than 12" below finish grade.
- I. The grounding resistance shall be tested by an approved independent testing laboratory, in the presence of the District Electrical Inspector, Electrical Technical Supervisor, Consulting Electrical Engineer and the District Electrical Engineer. The test results shall be submitted to the District Electrical Technical Supervisor, on an official form, for file, with copies distributed to the District Electrical Inspector and Electrical Engineer.

END OF SECTION