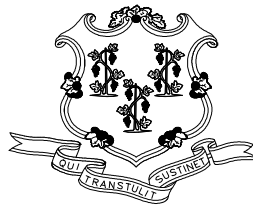


**PROJECT MANUAL  
VOLUME 3 OF 3**

**Additions and Renovations to  
Eli Whitney, Connecticut Technical High School**

**Hamden, Connecticut**

**Project No.: BI-RT-837 – CMR**



**State Of Connecticut  
Department Of Construction Services  
Bureau of Design and Construction  
Donald J. DeFronzo - Acting Commissioner**

**Prepared By:  
Antinozzi Associates, P.C.  
271 Fairfield Ave  
Bridgeport, Connecticut, 06604**

**June 18, 2012  
CMR—Bid Documents Submission**

**Additions and Renovations to  
Eli Whitney, Connecticut Technical High School**

**Existing Address:  
71 Jones Road  
Hamden, Connecticut 06046**

**New Address:  
"XX" Fairview Avenue  
Hamden, CT 06046**

**Project No.: BI-RT-837 -CMR**

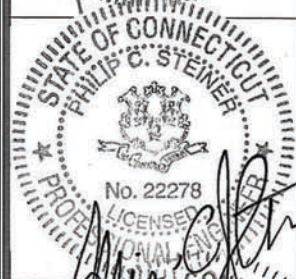
**Prepared By:  
Antinozzi Associates, P.C.  
271 Fairfield Avenue  
Bridgeport, Connecticut 06604**

**Seals & Signatures**



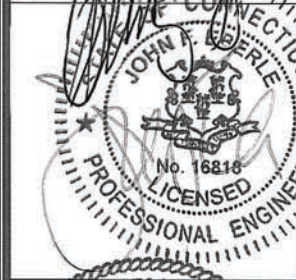
ANTINOZZI ASSOCIATES  
*(Print Consultant Name)*

*(Print Consultant Name)*



ALTIERI SEBOR WIEBER  
*(Print Consultant Name)*

*(Print Consultant Name)*



STANTEC CONSULTING  
*(Print Consultant Name)*

*(Print Consultant Name)*



THE DISALVO ERICSON  
GROUP  
*(Print Consultant Name)*

*(Print Consultant Name)*

REFER TO THE SEPARATE VOLUME OF DOCUMENTS ISSUED BY THE CMR (FUSCO CORPORATION) DETAILING THE PROJECT'S PROCUREMENT AND CONTRACTING REQUIREMENTS

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PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver, and install all work of this Section as shown on the drawings, as specified herein, and/or as required by job conditions.
2. Refer to specification Section 23 00 00 2.01 for Video recording of material, equipment, operation and on-site training .
3. Refer to Section 23 00 00, 1.13 for additional warranty requirements.
4. Refer to Section 23 00 00, 3.02 for additional maintenance requirements. Contractor to provide a complete maintenance log for each piece of equipment.
5. The contractor shall refer to specification 01 11 00 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that they remain active during the construction and renovation of the phased project.
6. Refer to specification Division 01. The Commissioning services for Division 23 systems are specified within Division 01 Commissioning. The General Contractor, the GC's Subcontractors and the Division 21 Contractor shall include all manpower, time, parts, labor, and resources required to accomplish the commissioning as specified.
7. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be with out the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.
8. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.
9. Perform all work in accordance with the above requirements and the provisions of all applicable codes, standards, and laws.
10. Due to the phasing of this project the contractor shall provide all tie-ins, live or otherwise required to provide functional systems for this project.
11. The following abbreviations used in the Specifications refer to organizations publishing specifications and standards. These shall be construed to mean the latest standard adopted (by the state and or local code) at the date of advertisement for bids and such specifications are made part of the Contract Documents to the same extent as if written out in full.

a. Standard Specifications and Abbreviations

AFF	Above Finished Floor
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CTE	Connect to Existing
FM	Factory Mutual
FP	Fire Protection
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC	Not in Contract
OSHA	Occupational Safety Health Act
SPK	Sprinkler
UL	Underwriters Laboratories, Inc.
UNO	Unless Noted Otherwise

1.02 REFERENCES

1. Related documents, drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 23 00 00, govern the work of this Section.
2. Work of this section shall be governed by the Contract Documents. Provide design, materials, labor, equipment, and services necessary to furnish, deliver and install all work of this section as shown on the drawings, as specified herein, and/or as required by job conditions and Code requirements.
3. The design, installation and equipment shall conform to all state and local codes including the 2005 Connecticut State Building and Fire Safety Codes including the 2009 supplements and all amendments thereto, NFPA 13-2002, the local Authority Having Jurisdiction (AHJ), the Owner's Insurance Company (Factory Mutual), and with all applicable building code articles and reference standards cited therein.
4. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.03 SCOPE OF WORK/DESCRIPTION

1. Complete wet fire sprinkler system with:
  - a. Removal and replacement (in a different location) of a portion of the existing 6" fire protection underground water supply piping. Include a new underground control valve and curb box assembly.

- b. Properly test, inspect and reuse (if acceptable test results and inspection) the existing 6" fire protection backflow preventer assembly. If unusable, supply and install a new 6" backflow preventer assembly. Supply and install two tamper switches on the backflow preventer control valves (wiring is by Division 26).
  - c. All of the existing fire protection system will be removed and properly disposed of. For additional information refer to the "F" series Drawings. Removal of the existing interior fire protection system is not by Section 21 00 00 (UNO) and shall be included in a separate demolition contract and is therefore not part of Section 21 00 00.
  - d. Remove the two existing riser check valve assemblies located in the basement/crawlspace. Provide four new riser check valve assemblies connected to the new 6" fire protection supply piping.
  - e. Include a new Fire Department Connection (FDC) assembly connected to the base of the new riser check valve manifold piping.
  - f. Provide seven new Sprinkler zone Control Assemblies (SCA) located in accessible locations of each zone/area.
  - g. Provide a small anti-freeze system to the sprinkler/s installed in the exterior dust collector assembly. Include any additional sprinkler heads required to protect above and around the wood frame construction mockups utilized in the shop areas. Include complete sprinkler protection above and below all mezzanines and loft areas.
  - h. Provide a dry pipe system for the sprinklers at the covered entrance canopy. Include sprinkler protection above and below the wood ceiling. All dry pipe and fittings shall be galvanized. The concealed pendants shall be dry type sprinklers.
  - i. Include a complete galvanized sprinkler test and drainage system piped to discharge at the building exterior or other Engineer and Architect approved location.
  - j. In finished areas, utilize concealed type sprinkler heads with concealed piping and hanger assemblies unless noted otherwise. In classrooms, workshops and other public areas where fire protection piping and equipment is Architect and Engineer approved to be exposed, provide uniform hanger assemblies, piping, fittings, and sprinkler head locations. All exposed material locations (in public areas) must be approved by the Architect and Engineer.
  - k. Provide seismic bracing installed in accordance with the requirements in NFPA 13. All hanger material (seismic and standard) shall be galvanized.
2. Work starts at:
- a. The removal and replacement (in a revised location) a portion of the existing exterior 6" underground FP piping. Include a new 6" underground control valve with curb box assembly.
3. General design:
- a. All piping and sprinklers shall be of the concealed type in areas where ceilings exist. Exposed piping and sprinklers shall be installed in areas without ceilings. All fire protection work shall be coordinated with other trades, the building's architectural features and with the ceilings, soffits, and partitions. Special care should be taken in areas where sprinkler heads are centered in ceiling tiles or with other ceiling features.

- b. Do not run exposed piping in front of windows and skylights. Keep all exposed piping as high as possible and as tight to walls and ceilings/decking as possible. Exposed piping and sprinklers shall be installed in coordination with the buildings structural and architectural features. Concealed piping should be elevated +/- 6" above the ceiling. Coordinate all piping with lights, diffusers, and all other equipment above the ceilings. Provide any additional piping, offsets, and hanger assemblies required to meet the aesthetic considerations of this project. Do not locate piping in areas where it would interfere with door swings or required head clearances or egress paths.
  - c. Provide all required drain and control valves. All valves shall be a maximum of 7'-0" above the finished floor, unless noted otherwise.
  - d. Do not attach any hanger assemblies directly to the underside of any roof assemblies. When supporting fire protection piping and equipment at the underside of roof construction, use "unistrut" type supplemental steel to span adjacent roof structure and attach equipment hangers to the "unistrut".
4. Additional equipment:
- a. Electric Bells (interior & exterior).
  - b. Alarm actuating devices.
  - c. Galvanized hanger equipment including seismic.
  - d. Required accessories, drains and test connections.
  - e. Rough cutting and patching.
  - f. Coordinate all fire protection wiring requirements with Division 26.
5. Related work specified elsewhere:
- a. Finished patching
  - b. Electrical wiring, including wiring of tamper switches
  - c. Fire extinguishers.
  - d. Painting of exposed fire protection piping located in public spaces.

#### 1.04 SUBMITTALS

The information shall be provided for review in a phased submittal process. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase the project is beginning it will be returned, not reviewed. This is a phased project and the Fire Protection System is required to be submitted to the Engineer in a manner that reflects the phasing of the project. The following shall be provided for each area under the present phase of construction for this project:

- 1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000, in accordance with the procedure specified in Section 230000.
- 2. Materials
  - a. Exterior and Interior Pipe and Fittings
  - b. Escutcheons
  - c. Sleeves
  - d. Control and Drain Valves

- e. Specialty Valves (Riser Check Valve, Dry Pipe Valve with Compressor and Anti-Freeze Assembly)
  - f. Fire Department Connection
  - g. Alarm Actuating Devices: Flow Switches, Tamper Switches, Low/High Air Switch, etc.
  - h. Valve Tags, Charts, Pipe Markers, and Equipment Signage
  - i. Piping Supports and Hanger Assemblies (including seismic as required by state code)
  - j. Pressure Gauges
  - k. Sprinkler Heads and Guards
  - l. Spare Sprinkler Cabinet
  - m. Fire Stopping Assemblies
  - n. Electric Alarm Bells
3. Hydraulic calculations for all sprinkler systems:
- a. Each calculation shall contain a water summary sheet indicating the pressure and flow required at the connection to the city main and the pressure available at the required flow. Include this information on associated shop drawing. Provide the drawing number of the remote area location on the calculation cover sheet.
  - b. Calculations are to be brought back to the underground street main connection. Calculations must print out results in a consecutive format representing actual flow direction. Do not submit calculations, which do not conform to this requirement.
  - c. Calculations shall include a 10-PSI (or 10% of available pressure/PSI at required flow/GPM) "cushion" between required and available water supply.
  - d. Hydraulic reference points shall be clearly indicated on drawings. Do not use "pipe numbers"; provide consecutively numbered reference points at all areas indicated on hydraulic calculations including at connection to street main.
  - e. All sprinklers in the remote area must be flowed in the calculations (i.e.: do not exclude sprinklers in small rooms, closets, etc). Do not include any unsprinklered spaces in the determining the square footage of the remote area. The remote area must be the minimum square footage indicated in the Contract Drawings. The use of quick response sprinklers shall not result in a reduction of the remote area/s indicated on the Contract Drawings. Grid calculations shall include "Peaking" process (per NFPA requirements) to ensure calculation of most remote area.
  - f. **HYDRAULIC SUMMARY DATA MUST BE INCLUDED ON SHOP DRAWINGS.** Summary data shall include: location, file number, density, remote area square footage, number of sprinkler heads flowing, GPM & PSI required at connection to city main, available PSI at required flow.
  - g. Remote areas shall be increased by 30% for any dry systems or any required sloped ceiling areas in accordance with NFPA 13.
4. Shop drawings
- a. Provide dimensional installation piping layout/s coordinated with all trades. Include all sprinkler heads, piping, drains; pipe sizes, hanger styles and locations, valves with identification numbers, alarm equipment, and all other items for a complete shop drawing. Submittal shop drawings shall be clear and legible. All sprinkler information must stand out on the shop drawings (i.e.: bold piping, etc. or lighter background). Reverse reading drawings are not acceptable. Do not



- draw piping intersecting with other piping that does not actually connect.
- b. Include a complete riser diagram indicating all fire protection equipment, hydraulic reference points, and elevations at each floor. Diagram shall include all information from the municipal water connection to the backflow preventer, riser, and riser control valve assembly.
  - c. Provide a full height building cross section noting elevations, types of construction, and locations of ceilings, walls/partitions, and sprinkler piping. Include a complete drawing index with each submittal and on the first drawing in the fire protection shop drawing set.
  - d. Include a complete drawing index with each submittal and on the first drawing in the fire protection shop drawing set.
  - e. Include a key plan for each drawing on projects with multiple drawings per floor.
  - f. Include a site plan indicating flow test location and data (including flow test elevation) north arrow, underground supply piping, adjacent fire hydrant locations, building location, and adjacent streets.
  - g. Determine any deviations from the specifications and drawings and clearly indicate them on shop drawings.
  - h. Submit and secure approval for all fire protection materials, drawings (including Coordination drawings) and calculations from the local AHJ and the Owner's insurance company, prior to any installation work. At completion of installation provide complete "As-Built" documentation. Include valve tag chart, test certificates, hydraulic calculations, hydraulic summary data, and a complete riser diagram (riser diagram shall include hydraulic reference points and valve tag numbers).
  - i. SHOP DRAWINGS AND "AS-BUILT" DOCUMENTS MUST BE EASILY READABLE. POOR QUALITY PRINTINGS, REVERSE READING DRAWINGS AND DRAWINGS WITH EXCESSIVE UNNECESSARY INFORMATION (IE: FIELD FABRICATION NOTES, ETC.) WILL NOT BE REVIEWED AND WILL BE RETURNED FOR RESUBMISSION.
  - j. Sprinkler shop drawing submittals must include a NICET Level III or Level IV certification number (or a PE stamp) as proof of design and/or review by said NICET/PE certified/registered person.
  - k. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
  - l. 1/8" shall be the minimum text size for all drawings.

5. Samples

- a. Submit (4) samples on each of the following items:
  - 1) Sprinkler heads
  - 2) Escutcheons
  - 3) Sprinkler head guards
  - 4) Valve signs, tags and charts
  - 5) Pipe markers
  - 6) Pipe hangers

6. Operating instructions and parts lists.
  - a. Before requesting acceptance of work, furnish five (5) printed and bound sets.
  - b. Provide a brief description of equipment and systems and basic operating features. Manufacturer's name, (include address and telephone number) model number, service manual, spare parts lists, wiring diagrams and descriptive literature for all components.
  - c. Include maintenance instructions, listing of possible breakdowns and repairs, instructions for starting and operation and detailed and simplified type, one line color-coded flow and wiring diagrams.
  - d. Provide witnessed CONTRACTOR'S MATERIAL AND TEST CERTIFICATE FOR ABOVE GROUND PIPING and UNDERGROUND PIPING (FIELD TEST REPORTS). Reports shall include required signatures along with printed names and titles of all witnesses.
  - e. Include the appropriate sections of NFPA 25, a copy of the fire protection valve tag chart and a copy of all hydraulic calculations.
  - f. Include a copy of the first year's required inspections and testing contract.
  - g. Provide a CD with electronic files (i.e., both .pdf and .dwg) of all approved fire protection As-Built drawings and hydraulic calculations.

#### 1.05 COORDINATION DRAWINGS

1. Refer to section 230000 for requirements.

#### 1.06 CLEARANCE FROM ELECTRICAL EQUIPMENT

1. Piping (except for piping directly supplying just the sprinklers in such rooms) is prohibited except as noted, in:
  - a. Electric and telephone rooms and closets
  - b. Elevator Machine Rooms
  - c. Prohibited, except as noted, directly over or within 5 feet of: transformers, substations, switchboards, motor control centers, bus ducts, etc.
2. When piping is located closer than the clearance distances listed in the National Electric Code (NFPA 70), provide drip pans under piping. Pipe drip pan drainage to an approved location.

#### 1.07 QUALITY ASSURANCE

1. Quality of Materials
  - a. All equipment and materials to be UL listed. All equipment and materials shall also be and Factory Mutual approved (unless noted otherwise).
  - b. New, best of their respective kinds and free of defects.
  - c. Electrical equipment: Listed by Underwriters Laboratories or bearing their label.
  - d. Secure approval from Architect, Engineer and all authorities having jurisdiction for materials, equipment, and installation prior to installation.
  - e. All fire protection Work shall be free from defects in workmanship and materials for a period of eighteen (18) months from the date of final acceptance of each phase of the project. Refer to the phasing documents for project duration. The CM/GC shall provide the dates of completion of each phase as it relates to the

phasing documents. The contractor shall meet all local and state codes. Provide (as part of the contract) all required inspections and testing for each phase of the project.

1.08 WARRANTY

1. The 18 month warranty period shall begin at the completion of each phase. The fire protection installation acceptance shall be provided by the commissioning agent, for each phase of the project. Refer to Division 01 for additional information. The Sprinkler Contractor shall repair all defects, which develop or are discovered within this period, to the satisfaction of the Owner, at no additional cost. NOTE: AN ADDITIONAL ONE YEAR INSPECTION/ WARRANTY PERIOD BEGINS AT THE END OF THE LAST PHASE OF CONSTRUCTION, AS ACCEPTED BY THE COMMISSIONING AGENT.

1.09 MAINTAINENCE AND TRAINING

1. The contractor shall repair all defects, which develop or are discovered within the Warranty period, to the satisfaction of the Owner, at no additional cost.
2. The contractor shall maintain the fire protection system for the entire duration of the project. The contractor shall provide as part of the maintenance program, all the required inspections and testing for each phase of the project. The contractor shall repair all defects, which develop or are discovered within the maintenance period, to the satisfaction of the Owner, at no additional cost.
3. The contractor shall meet all local and state codes.
4. The contractor shall provide On-Site Training to the owner's representatives. The on-site training shall be no less than (1) day per phase of the project. The on-site training shall be provided after the installation's acceptance, for each phase of the project. The fire protection installation's acceptance shall be provided by the commissioning agent. Refer to the phasing documents for additional information.

1.10 CONTRACT DOCUMENTS

1. The Contract Documents are generally diagrammatic and are intended to convey the scope of work and indicate general arrangements of piping, sprinkler heads, etc. Any work in addition to or different from these Contract Documents will not be considered an extra cost to the Contract. The Contractor shall examine the site of the proposed work to evaluate any existing conditions that may affect their work.

PART 2 - PRODUCTS

2.01 EXTERIOR PIPE AND FITTINGS

1. Underground piping shall be equal to U.S. PIPE double cement lined ductile iron class 52 pipe, with push-on rubber gasketed joints installed and anchored in accordance with

NFPA 24. Provide retaining glands for attachment to mechanical joint fittings. Anchoring of pipe and fittings shall consist of rodding and/or thrust blocks.

2. Underground fittings shall be ductile iron class 250 (ANSI) A21.10 and A21.11, mechanical joint type anchored by rods and/or thrust blocks in accordance with NFPA 24.
3. Water tight sleeves:
  - a. Masonry walls and slabs: Schedule 40 galvanized steel pipe with integral water stop.
  - b. Piping seal: (interior walls in contact with earth): interlocking expandable synthetic rubber links, assembled with corrosion resistant bolts, nuts, and pressure plates. Similar to: LINK-SEAL. Install according to manufacturer's specifications.
4. Exterior service valves.
  - a. Curb type, 175 PSI WWP, mechanical joint ends, IBBM, double disk, non-rising stem, gate type with square spindle nut, similar to Stockham Model # G-635-0.
  - b. Provide adjustable tar corrosion proof extension shaft and flush box with lock type cast iron cover, marked as directed with 2 operating wrenches

## 2.02 INTERIOR PIPE AND FITTINGS

1. Piping
  - a. Standard weight steel (Schedule 40) except as noted, seamless or welded mild steel, ASTM A-135, A-795 or A-53 for size 1" and larger.
  - b. Schedule 10 steel pipe may be used for size 1¼" and larger.
    - 1). No threaded or cut grooved connections on Schedule 10 pipe.
  - c. Galvanized pipe must be used for all dry sprinkler piping, test and drain piping, interior piping between Siamese connection and check valve, piping for auto ball drip and for any interior piping subject to alternate wetting and drying. All exposed pipe and fittings in public areas shall be galvanized.
  - d. Provide chrome plated brass pipe and fittings for any exposed 2" main drain test piping at the building exterior.
2. Fittings:
  - a. Cast iron threaded: Standard weight, ANSI B-16.4.
  - b. Cast iron flanged fittings and flanges: Standard weight, ANSI B-16.1.
  - c. Malleable iron: Threaded and banded, standard weights, ANSI B-16.3.
  - d. Steel welding: Standard seamless steel, ANSI B-16.9 and ASTM A-234.
  - e. Steel flanges: ANSI B-16.5, ASTM A-181 Grade 1 up to 300-PSI.
  - f. Grooved end ASTM A-536 ductile iron FireLock® fittings, or standard ASTM A-536 ductile iron or ASTM A-234 or A-53 steel grooved end fittings, galvanized in accordance with ASTM A-153, and bolted clamp type ASTM A-536 ductile iron couplings, galvanized in accordance with ASTM A-153, with synthetic rubber sealing gaskets for rolled grooved end pipe, Grade "E" EPDM Type A, 250-PSI WWP. Allowed for size 1¼" and larger. Similar to: Victaulic Co.
    - 1). Rigid couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in

accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's recommendations. Contractor shall remove and replace any improperly installed joints.

- a) 1-1/4" thru 4": "Installation Ready" rigid type coupling designed for direct "stab" installation onto grooved end pipe without prior disassembly of the coupling similar to: Victaulic FireLock® EZ Style 009.
- b) 5" and Larger: Standard rigid joint similar to: Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
- 2) Flexible couplings: Use in seismic areas where required by NFPA 13. Victaulic Style 75 or 77.
- 3) Grooved Joint Flange Adapters: ASTM A-536 ductile iron casting, flat faced, for incorporating flanged components with ANSI Class 125, 150 and 300 bolt hole patterns to a grooved system, similar to: Victaulic Style 741, 743, or 744.
- g. Plain end fittings and bushings are NOT PERMITTED.
- h. All reducing fittings shall be tapered. Reducing couplings are allowed for one "nominal" pipe size reduction (i.e.: 6" x 4", 3" x 2½", etc).
- i. Provide galvanized fittings for all exposed piping in public areas, for all test and drain piping, for auto ball drips and for any piping subject to alternate wetting and drying (ie: FDC).

#### 2.03 ESCUTCHEONS

1. Two piece hinged, chrome plated metal. For exposed piping through floors, walls, partitions and ceilings. Similar to: ARGCO series.

#### 2.04 SLEEVES

1. Install galvanized steel pipe or 16 gauge galvanized sheet metal sleeves for pipes passing through floors, walls, and partitions. Sleeves shall be sized per NFPA requirements. Floor sleeves shall project one inch above finished floor to prevent seepage.
2. All sleeves passing through any rated construction shall be sealed with a UL listed fire and smoke resistive assembly in accordance with NFPA Standards. Grout-in all sleeves through concrete walls and floors.

#### 2.05 CONTROL AND DRAIN VALVES

1. General: Interior valves shall be UL and FM approved. Similar to: KENNEDY, NIBCO, Victaulic or MILWAUKEE.
2. Interior control valves:  
2" and smaller:
  - a. Butterfly type slow close indicating valve with built-in tamper switch, 175-PSI. Similar to MILWAUKEE "Butterball" Model No. BB-SCS02, or BB-VSCS02.
  - b. OS&Y gate type threaded bronze, 175-PSI WWP. Similar to: NIBCO model T-104-O.

- c. Ball type slow close indicating valve with built-in pre-wired tamper switches, brass body, grooved or threaded ends, 350-PSI WWP. Similar to: Victaulic FireLock® Series 728.
- 2 ½" – 6":
- a. Tight closing, epoxy coated ductile iron, elastomer encapsulated disc, grooved type butterfly valves, 300-PSI WWP, with stainless steel shaft, lifetime bearings, hand wheel gear operator with position indicator, and built-in tamper switch. Similar to: Victaulic "FireLock", series 705W WRD.
  - b. Flanged OS&Y gate type, RESILIENT WEDGE, 175-PSI WWP, pre-grooved stem for tamper switch, tapped and plugged boss. Similar to: NIBCO model F-607-RW.
  - c. Grooved OS&Y gate type, RESILIENT WEDGE, 200-PSI WWP, brass rising stem, tamper switch, cast iron bonnet and disc, EPDM seals. Similar to: Victaulic Series 771.
3. Drain and Test Valves:
- a. Threaded bronze angle or globe type with composition disc, 175-PSI. Similar to: NIBCO KT-65, KT-211, KT-67, and KT-301.
  - b. Grooved or threaded, bronze globe type with dual polycarbonate sight glasses with ½" orifice, EPDM seats and Nitrile o-rings, 300-PSI. Similar to: Victaulic Style 747M Zone Control Module.
  - c. Provide valves (not plugs) as required and at indicated locations for complete drainage of systems.
  - d. Pipe all drains to building exterior. Drains which spill over a floor drain, sump pit, or mop sink, will only be permitted with approval from the Engineer and Owner. Provide any required pipe, fittings, and labor to terminate drains at approved coordinated locations.
  - e. At system low points where drain piping does not extend to a drain receptacle, provide a threaded hose and adapter at the valve outlet (where permitted by the Engineer).
  - f. All sprinkler test and drain piping must be piped to the building exterior.
4. Alarm test module:
- a. Consisting of sight glass, inspector's test valve, auxiliary drain valve, and properly sized test orifice, pipe and drain as indicated and/or required. Provide a pressure relief valve for gridded systems or where static or residual pressures can exceed 150 -PSI.
  - b. Included in Victaulic Style 747 riser manifold assembly.
  - c. Sized in accordance with NFPA requirements.
5. Check valves:
- a. 2" and smaller: spring type, threaded bronze, bronze disc, 175-PSI. Similar to: NIBCO KT-403-W.
  - b. 2 ½" and larger: Grooved, 250-PSI, (except as noted). Similar to: Victaulic "FireLock", series 717.
6. Automatic ball drips:
- a. ¾" bronze with both ends threaded. Similar to: POTTER-ROEMER Model 5984. Pipe to approved drain location.

7. Riser Check Valve Assembly
  - a. Grooved riser check valve with 2" drain/test connection, gauges, and required accessories.
  - b. Alarm water flow switch to actuate main fire alarm panel and shut down of ventilating equipment.
  - c. Similar to: Victaulic FireLock® Series 717R.
  
8. Dry pipe valve assembly
  - a. Flanged or grooved unit with alarm switches to actuate building fire alarm system and local electric alarm bell, low air supervisory switch, drains, gauges, test apparatus with required accessories, air compressor, accelerator, anti-flooding device, and pressure maintenance device. . The dry pipe valve shall be a positive latching clapper, differential type dry valve. Dry pipe valve shall be re-settable with a resetting bar and not require priming. Dry valve shall be UL listed and Factory Mutual approved. Air pressure to water pressure area differential to be approximately 6 to 1. Dry valve trim piping shall be galvanized and include a connection for a non-interruptible circuit closer. Valve body shall be ductile iron
  - b. Similar to: VIKING Corporation, Victualic, Tyco, or pre-approved equal. Viking Dry Pipe Valve Model F-1.
  - c. All wiring between building fire alarm panel and dry pipe system to be responsibility of Division 26.
  - d. Air Maintenance Compressor:
  - e. Sprinkler systems requiring an air supply with a capacity of 335 gallons or less shall be equipped with a riser mounted, electric motor-driven, air-cooled, single-stage, oil-less compressor. Air compressor motor shall be 1/6 to 1/2 horsepower in size and produce sufficient cfm at 40 PSI, to fill the sprinkler system in 30 minutes or less. The field adjustable pressure range of air compressor shall be 1.5 - 75 PSI. Air compressor discharge outlet shall be equipped with a pressure relief valve with a factory setting of 65 PSI. Air compressor discharge piping will include a 1/4" check valve to prevent system air pressure loss. The air compressor assembly shall be Factory Mutual approved as an air maintenance device. Similar to: GENERAL AIR PRODUCTS Models OL11016AC, OL21533AC, or OL33550AC. Include a desiccant air dryer and coalescing filter assembly similar to AD3400 & F3500.

## 2.06 FIRE DEPARTMENT CONNECTION

1. Flush type (3way) top outlet:
  - a. Cast brass body, with drop clappers. Solid brass plate with lettering as selected. Brass 2 1/2" double female snoots with rigid end NPT x pin lug hose thread swivels, pin lug plugs and chains.
  - b. Size: 2 1/2" x 2 1/2" x 4".
  - c. Finish of all exposed parts to be selected by Architect.
  - d. Words: "AUTO SPKR " cast in.
  - e. Similar to POTTER-ROEMER, Tyco, Victaulic or pre-approved equal POTTER-ROEMER Model 5033 -D-F.
  - f. Thread types to comply with local requirements.
  - g. Provide auto ball drip at base of body (piped to building exterior).
  - h. Similar to: POTTER ROEMER Model 5982 & 5984.

- i. Verify final FDC finish with Architect. Verify FDC style and location with the local Fire Department.

2.07 ALARM ACTUATING DEVICES (Coordinate with Division 26)

- 1. Closed circuit tamper-switches to operate within two revolutions of valve wheel.
  - a. Built-in models or Similar to: Tyco, Victaulic or pre-approved equal POTTER Electric Signal Co. model OSYSU-A2 or SYSTEM SENSOR model OSY2.
  - b. All wiring from tamper switches to building fire alarm panel, to be responsibility of Division 26.
  
- 2. Closed circuit water flow indicators with retarding device to prevent false alarms from line surges.
  - a. Similar to: Tyco, Victaulic or pre-approved equal POTTER Electric Signal Co., model VSR-F for 2" and larger, and POTTER model VSR-SF for 1½" and smaller or SYSTEM SENSOR WFD Series.
  - b. All wiring from flow switches to building fire alarm panel, to be responsibility of Division 26.
  
- 3. Closed circuit pressure switches:
  - a. Similar to: Tyco, Victaulic or pre-approved equal POTTER model PS10-2A. Pressure type waterflow alarm switch with a ½" NPT male pressure connection to be connected into the intermediate chamber of a dry pipe system and shall be actuated by any flow of water to or in access of the discharge from one sprinkler head. Switches shall have a maximum service pressure rating of 250 PSI and shall be factory adjusted to operate at a pressure of 4 to 8 PSI. There shall be two SPDT contacts rated at 10.0 Amp. @ 125/250VAC and 2.4 Amp. @ 0.30VDC. The switch housing shall be weather proof and oil resistant. The cover shall incorporate tamper resistant screws.
    - 1) Alarm waterflow pressure switch to actuate main fire alarm panel, local electric alarm bell, and shut down of ventilating equipment. All wiring of waterflow switches to be responsibility of Division 26.
  - b. Similar to: Tyco, Victaulic or pre-approved equal POTTER model PS40-2A. Air pressure supervisory switch with a ½" NPT male pressure connection to be connected into the air supply line on the system side of any shutoff valve. A bleeder valve shall be connected between the air line and this switch to provide a means of testing the operation of this supervisory switch. The switch shall contain SPDT (Form C) switches. One switch shall operate at a pressure decrease of 10 PSI from normal, the second switch shall operate at a pressure increase of 10 PSI from normal. Switch contacts shall be rated at 10.0 Amp. @ 125/250VAC and 2.5 Amp. @ 0.30VDC. Switches shall have a maximum service pressure rating of 250 PSI and shall be adjusted from 10 to 175 PSI. The switch housing shall be weather proof and oil resistant. The cover shall incorporate tamper resistant screws.
  - c. All wiring from pressure switches to building fire alarm panel, to be responsibility of Division 26.



2.08 VALVE TAGS, CHARTS, PIPE MARKERS AND EQUIPMENT SIGNAGE

1. Tags
  - a. Brass 18 gauge with 1/2" stamped numbers and 1/4" letters filled with black paint. Not less than 1 1/2" inches round with 3/16" top hole.
    - 1). Similar to: Tyco, Victaulic or pre-approved equal SETON Style No. 65542.
  - b. Provide on all valves and controls identifying numbered metal tags, with letter to indicate system (FP) fastened by heavy brass hook and chain.
    - 1) Similar to: Tyco, Victaulic or pre-approved equal SETON Style Nos. 16197 and 16182.
2. Charts
  - a. Provide (two) frame mounted and laminated: Valve tag charts along with a diagrammatic/schematic diagram showing essential features of system.
  - b. All fire protection control, test and drain valves shall be tagged.
  - c. Valve numbering and lettering shall correspond to designation on the metal valve tags.
  - d. The valve tag chart shall indicate valve location, function, and area controlled. Minimum size is 11" x 17".
3. Pipe Markers
  - a. Provide 1/2" wide self-adhesive pipe markers with flow arrows at reasonable locations (not to exceed 30' intervals) and in accordance with Section 230000, on all concealed and exposed piping.
    - 1) Similar to: SETON brand style Nos. M4268 and M4167.
4. Equipment Signage
  - a. Provide proper signage on all fire protection valves and devices, describing device and function in accordance with NFPA requirements.

2.09 PIPING SUPPORTS AND HANGER ASSEMBLIES

1. Top Beam Clamps
  - a. Carbon steel clamp body with hardened steel cup point setscrew and locknut. Body shall be tapped through to permit extended adjustment of threaded rod.
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Figures 65 and 66.
  - c. Provide retaining straps for all beam clamps.
2. Hanger Rods
  - a. Carbon steel, continuous thread sized in accordance with NFPA 13 requirements.
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Figure 99.
  - c. Do not bend hanger rods. Use appropriate offsetting brackets/clamps.
3. Swivel Rings
  - a. Carbon steel, galvanized. (For sizes 1" and larger).
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Figure 2.

4. Concrete Anchors
  - a. Maximum loading, including pipe contents, covering and all required loads shall be 75 percent of rated load, tested in accordance with ACI 355.2 and ICC-ES AC 193 for use in structural concrete, plated with dull zinc finish.
  - b. Similar to: POWERS 3/8" and 1/2" Snake+ or pre-approved equal.
  - c. Use only at Owner approved locations.
5. Side Beam Brackets
  - a. Carbon steel galvanized flush back plate with threaded eye socket, for pipe sizes 1" through 4".
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Fig. 57.
6. Split Ring Hangers
  - a. Carbon steel, galvanized, hinged split ring extension hanger.
  - b. Similar to: ERICO Caddy Macrofix Plus NI 429 or pre-approved equal.
7. Steel Rod Couplings
  - a. Carbon steel, galvanized.
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Fig. 70.
8. Sway Bracing (Seismic Hangers):
  - a. Carbon steel, UL/FM approved.
  - b. Similar to: Tyco, Victaulic or pre-approved equal TOLCO Figures 906, 907, 908, 909, 910, 975, and 1000.
9. Other Hanger Materials:
  - a. All other hanger materials, assemblies and methods shall be UL/FM approved for their intended application.
10. All hanger material (including seismic) must be galvanized.

#### 2.10 SPRINKLER HEADS & GUARDS

1. Cast brass, closed, quick response bulb type, standard spray with 1/2" discharge orifice.
  - a. Include complete sprinkler head descriptions on shop drawings. Provide make, model, temperature rating, and Sprinkler Identification Number (SIN) for all sprinkler heads.
  - b. Similar to: Tyco, Viking or pre-approved equal Victaulic models unless noted otherwise.
  - c. Utilize ordinary temperature ratings, except as noted. Utilize high temperature ratings where subject to abnormal heating and conditions such as near heaters, heating lines, and in blast of heaters.
  - d. On exposed piping, use upright heads wherever possible and pendent type where necessary. Provide head guards on all exposed sprinkler heads.
  - e. All sprinkler heads shall be quick response type (unless noted otherwise).

2. Sprinkler head types
  - a. On exposed piping:
    - 1) Exposed upright or pendent type, ½", brass. Similar to: Tyco, Viking or pre-approved equal Victaulic Model V2704 or V2708. Architect shall select finish.
    - 2) Horizontal sidewall type, ½", brass. Similar to: Tyco, Viking or pre-approved equal Victaulic Model V2710. Architect shall select finish and style.
  - b. On concealed piping:
    - 1) Concealed pendent type, ½", brass, adjustable, with cover plate. Similar to: Tyco, Viking or pre-approved equal Victaulic Model V3802. Architect shall select finish.
    - 2) Dry horizontal semi-recessed sidewall type, ½", brass, adjustable, with escutcheon. Similar to: Tyco, Viking or pre-approved equal Victaulic Model V3610. Architect shall select finish.
    - 3) Horizontal concealed sidewall type, ½", brass. Similar to: Tyco, Viking or pre-approved equal Viking VK408. Architect shall select finish and style.
    - 4) Concealed dry pendent type, ½", brass, with cover plate. Similar to: Tyco, Viking or pre-approved equal Victaulic Model V3618. Architect shall select finish.
  - c. Sprinkler head guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer for specific sprinkler heads they are protecting. Similar to Tyco, Viking or pre-approved equal Victaulic V27, V34 & V36.

## 2.11 CABINETS

1. Spare Sprinkler Cabinet
  - a. Enameled red steel with not less than 12 extra sprinkler heads and cover plates including each temperature rating and type used. Similar to: Tyco, Victaulic or pre-approved equal POTTER-ROEMER Model 6162.
  - b. Include a sprinkler head wrench of each type used.
2. Elevator Shaft Sprinkler Control Valve Cabinet
  - a. Cabinet shall be sized to accommodate a 1" control valve for elevator shaft sprinkler. Approximate size will be ±12" H x ±18" W x ±6" D. Refer to Architectural drawings for space limitations.
  - b. Cabinet construction shall be of 20-gauge sheet metal box, with a 20-gauge tubular steel door and 18-gauge frame.
  - c. Cabinet shall be recessed mounted.
  - d. Door style shall be flush solid metal door with lock OR as otherwise specified by the Architect.
  - e. Finish shall be powder-coated with an electrostatically applied, thermally fused, recoatable white polyester finish OR custom finish as otherwise specified by the Architect.
  - f. Labeling shall be: "ELEVATOR SHAFT SPRINKLER  
CONTROL VALVE
  - g. POTTER-ROEMER, Series 1830 or engineer approved equal. In fire rated construction: Similar to Fire rated cabinet POTTER-ROEMER FRC1830.

3. Sized for sprinkler control assembly (SCA)
  - a. Sized for SCA, similar to POTTER-ROEMER Model 1406. Custom Size for SCA shall be  $\pm 30$ "H x 30"W x 10"D.
  - b. Construction: 20 gauge sheet metal box, 20 gauge tubular steel door with 20-gauge frame and a continuous steel hinge (brass pin). Steel corner seams welded and ground smooth. All components powder-coated with an electrostatically applied, thermally fused, recoatable white polyester finish, with a cam latch type handle.
  - c. Labeling: "SPRINKLER CONTROL ASSEMBLY". In fire rated construction: Similar to Fire rated cabinet POTTER-ROEMER Model FRC1406.

#### 2.12 FIRE STOPPING ASSEMBLIES

1. All fire stopping assemblies shall be UL listed.
  - a. Similar to: Tyco, Victaulic or pre-approved equal HILTI Firestop Systems.

#### 2.13 ELECTRIC ALARM BELLS

1. 6" diameter Underwriters listed 24-volt DC type. Include weatherproof box and seal. Provide one electric bell inside the fire protection room and one on the building exterior. Coordinate exterior location with Architect.
  - a. Similar to: Tyco, Victaulic or pre-approved equal POTTER ELECTRIC SIGNAL CO. Model PBD246.
  - b. Electric bell assemblies to be wired by Division 26.

### PART 3 - EXECUTION

#### 3.01 PIPING - GENERAL

1. Approximately as indicated, modify to suit building conditions, avoid interference with other trades and maintain pitch.
2. Design documents are schematic, provide additional offsets, fittings, valves, drains, sprinklers, etc., where required by construction, code, and Work of other trades.
3. Run in chases, recesses, shafts, hung ceilings and beam cuts where applicable. Do not cover before examination and testing.
  - a. Run parallel with or at right angles to walls and other piping, neatly spaced with plumb risers.
  - b. Maintain 1-inch clearance between hubs, coverings and adjoining work.
4. Provide reducing fittings for changes in pipe size.
  - a. No bushings or street elbows permitted.
  - b. Grooved reducing fittings are acceptable for decreases of one nominal pipe size. (I.e.: 6" x 4", 3" x 2 1/2", etc.).
5. Concealed piping in hung ceilings:
  - a. Obtain ceiling heights from Architectural Drawings.

6. Joints:
  - a. In accordance with manufacturer's instructions.
  - b. Provide dielectric fittings/nipples wherever pipes of dissimilar materials are connected.
  - c. Screwed piping threads: Clean cut of exact length, ream pipe after cutting and threading, apply approved compound on male threads only, apply graphite on drain plugs.
  - d. Use extra heavy pipe for nipples where unthreaded portion of pipe is less than ½ inches long. Use close nipples only where necessary.
  
7. Welded piping: (Shop application only, NO FIELD WELDING)
  - a. Oxyacetylene or electric arc process in accordance with latest accepted practice and in accordance with Underwriters Laboratories.
  - b. Performed only by welders meeting qualifying tests for strength welds in pressure piping of ANSI.
  - c. Provide, have tested, and submit for review, standard sample welds for each welder before he commences work.
  - d. Remove foreign matter from ends of pipe before tacking and welding, align pipe ends concentric, then tack weld to prevent misalignment during welding.
  
8. Welding fittings:
  - a. Factory made, forged steel only permitted.
  - b. Shop or field fabricated: NOT PERMITTED
  - c. Hammer, clean and flush out piping after welding to remove scale, slag, welding beads, etc.
  
9. Mechanical outlet fittings:
  - a. Must be equal to Victaulic #920 for sizes available, and #920N where a #920 is not available in the required size. No other types or styles will be permitted.
  
10. Grooved Joints:
  - a. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations.
  - b. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Manufacturer shall supply gaskets.
  - c. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

### 3.02 PIPING SUPPORT

1. Maximum loading, including pipe contents, covering and all required loads, 75% of rating.
  - a. Support piping so as to secure in place, maintain required pitch and prevent vibration. Design and installation shall be in accordance with NFPA 13.
  - b. Provide for expansion and contraction.
  - c. No piping shall be hung from other piping, ductwork, conduit, ceiling structure, etc.

2. Suspended horizontal piping:
  - a. Chain, strap, perforated bar and wire hangers: NOT PERMITTED.
  - b. Suspension from inserts, beam clamps, steel fishplates, cantilever brackets, or other approved methods with threaded rods with double nuts tightly made up.
    - 1) Where overhead construction does not permit fastening hanger rods in required locations, provide additional steel framing as required and reviewed.
    - 2) Maximum hanger spacing per NFPA 13 requirements.
3. Vertical piping:
  - a. Riser clamps, bolted on each side of pipe and bearing equally on structure.
    - 1) Similar to: TOLCO Riser Clamp Fig. 6.
  - b. Minimum clamp spacing: At every floor (or at a maximum of 15' on center).
  - c. At offset from vertical: By hanger on horizontal branch close to riser or base fitting on foundation.
4. If removal of existing fireproofing is required for installation purposes, such removal shall be kept to a minimum. The Fire Proofing Contractor shall replace all removed fireproofing with new, to the satisfaction of the Owner at no additional cost to the owner.
5. The Contractor shall provide all supplementary structural steel required or spanning between, or connecting to, building structural members, for the hanging or support of piping. Welding to or drilling into building structural members will not be permitted without the approval of the Owner and the Structural Engineer.
6. Supports: In accordance with NFPA 13, support from overhead construction and maintain maximum headroom.

### 3.03 CLEANING AND ADJUSTING

1. Brush and clean work, prior to concealing, painting, and acceptance. Perform in stages, if directed.
2. Painted or exposed work that is soiled or damaged by this contractor must be cleaned and repaired to match adjoining work before final acceptance.
3. Remove debris from the inside and outside of all material and equipment.
4. Flush out piping at least twice after installation and before final connections are made in a manner as directed and/or approved by the Owner, and in accordance with NFPA requirements. Make all temporary connections and furnish all appliances required for the purpose of proper cleaning and testing of all materials at no extra expense to the Owner.
5. Adjust any pressure reducing/restricting valves and automatic control devices.
6. Adjust alarm-indicating devices to meet the requirements of the local Fire Marshal.
7. Remove and properly dispose of all unused or waste material.

8. Temporary Fire Protection: In accordance with the project Phasing, until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses.

#### 3.04 TESTS

1. Pressure test piping with water at 200-PSI for two (2) hours and in accordance with NFPA requirements. Provide required labor, material, equipment, and connections. Submit results for review and include results in O&M manuals.
2. Perform all acceptance testing required by NFPA 13. Provide required labor, material, equipment, and connections. Submit results for review and include results in O&M manuals.
3. Repair or replace defective work as directed at no extra cost. Pay for clean up and restoration or replacement of damaged work of others due to tests (which Section 210000 may be responsible for).

#### 3.05 VALVES

1. Provide control valves where indicated or required. Valves shall be accessible.
2. Seal valves in proper position and provide approved type tag and/or signage indicating purpose of valve. Indicate accurate field pressure settings of any pressure-activated valves.
  - a. Provide control valves with 24 volt closed circuit supervisory tamper switches, (see Alarm Actuating Devices section of this specification), mounted in accordance with manufacturer's requirements.
  - b. Install all valves at a maximum of 7'-0" above floor unless indicated otherwise on contract drawings.

#### 3.06 SPRINKLER HEADS

1. All sprinkler heads shall be used in accordance with all conditions, requirements, and limitations of their listing and in accordance with NFPA 13 and all other applicable codes.
2. Install sprinkler heads, in hung ceiling areas, center of tile and align heads symmetrically with ceiling tiles. Install sprinkler heads in gypsum and plaster ceilings symmetrically and align with adjacent ceiling fixtures.
3. Install all concealed sprinklers on return bends unless otherwise approved.
4. Provide factory applied custom finishes as determined by the Architect.
5. Refer to Architectural ceiling plans for preferred locations of sprinkler heads. Refer to architectural sections and details for required pipe routing. Note Architect and/or Engineer of any conflicts.

6. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.
7. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.07 RENOVATION OF AREAS NOT IN PRESENT PHASE OF PROJECT

1. In unrenovated areas (areas not in the present phase of work) that will require any kind of work, including but not limited to the installation of new pipe, ductwork, and/or conduit entering, penetrating and/or passing through due to the phasing of the project, this contractor shall be responsible for the covering, moving, relocation, replacing and protecting of the Owner's property. The Owner's property shall include but not be limited to furniture, equipment, furnishings, walls, floors and ceilings. This contractor shall be responsible for the cleaning of the room to the level and condition that the room was prior to the commencement of work. A representative of the Owner shall review the existing condition of the room prior to work commencing. The cleaning shall include the wiping of and/or washing of walls, floors, counter tops, desktops and any and all surfaces that are affected by the installation. After the work has been completed, the Owner's representative shall provide confirmation that the room has been cleaned to the level that it was prior to the work commencing. This contractor shall be responsible for the moving, relocation and putting back in place any and all equipment that will be in the area of work. If this contractor does not clean the room to the level to which it was found, the contractor shall pay any and all costs associated with the room clean-up. If this contractor does not put back in place any and all equipment that will be in the area of work, the contractor shall pay any and all costs associated with the room set-up.

END OF SECTION



SECTION 22 00 00 - PLUMBING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment and services necessary to furnish, deliver and install all work of this Section as shown on the drawings, as specified herein, and/or as required by job conditions.
2. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be without the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.
3. Refer to specification Division 019100. The Commissioning services for Division 220000 systems are specified within Division 019100 Commissioning. The General Contractor, the GC's Subcontractors and the Division 26 Contractor shall include all manpower, time, parts, labor, and resources required to accomplish the commissioning as specified.
4. The contractor shall refer to specification 01110 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that, they remain active during the construction and renovation of the phased project.
5. Refer to Section 230000, 1.13 for all warranty requirements.
6. Refer to Section 230000 2.2 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training.
7. Due to the phasing of this project the contractor shall provide all tie-ins, live or otherwise required to provide functional systems for this project.
8. Refer to Section 230000, 3.2 for all maintenance requirements. This contractor provides a complete maintenance log for each piece of equipment.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of the Contract General Conditions, Section 230000 General Provisions, Section 230500 Removals, applicable division 23 sections and with the provisions of all applicable Local, State, and Federal Codes and laws including the 2003 IPC (International Plumbing Code).

1.03 SCOPE OF WORK

1. The work under this Section shall include all incidentals, labor, material, equipment, appliances, services, hoisting, scaffolding, supports, tools, consumable items, fees, licenses, and administrative tasks required to complete and make operable the plumbing work shown on the drawings and specified herein, including the International Plumbing Code.
2. The Contractor shall furnish and install all equipment as necessary to provide a complete installation including system check out and start up on each item and system. The following equipment shall be provided:
  - a. Sanitary, waste, and vent systems.
  - b. Building sanitary drain to 5'-0" outside building.
  - c. Storm and roof drainage systems.
  - d. Building storm drain to 5'-0" outside building.
  - e. Domestic hot and cold water system.
  - f. Fire protection water service from point of connection within the building.
  - g. Gas systems.
  - h. Kitchen equipment plumbing support systems and connections.
  - i. Pipe materials
  - j. Pipe hangers and supports
  - k. Insulation
  - l. Valves
  - m. Cross connection protection devices.
  - n. Pipe sleeves and seals.
  - o. Drains
  - p. Cleanouts
  - q. Plumbing fixtures
  - r. Water heating equipment
  - s. Pumps
  - t. Grease interceptors
  - u. Hose bibbs.
  - v. Access panels.
  - w. Misc. plumbing specialties.

1.04 WORK BY OTHER DIVISIONS

1. Division 26 shall provide power wiring to electrical devices. Section 220000 shall provide and install all control wiring required for equipment operation. Section 220000 shall provide motor starters for installation by Division 16.
2. Plumbing devices, faucets, valves and fittings required for food service equipment including gas solenoid shut-off valves for kitchen equipment shall be provided by other divisions. Section 220000 shall provide and install piping connections. Coordinate requirements. Food service equipment shall be assembled by other divisions.

3. Piping and related excavation and backfilling for services (except the fire protection service) from the utility connections to a connection point 5'-0" outside of the building line.
4. Piping and related excavation and backfilling for fire protection service from the water supply source to a connection point 5'-0" outside of the building line.

1.05 MATERIALS, EQUIPMENT AND SYSTEM

1. Factory wiring of components shall conform to all State, Local, and Federal Codes and Laws.
2. The criteria of design and performance to produce the required operation are based on equipment of the named manufacturers. Equipment of other manufacturers shall be considered, subject to its acceptability in the Engineer's judgement and opinion. The equipment must conform to the operational characteristics and dimensions established by specified item and the drawings for mechanical spaces and other clearances.
3. The following manufacturers, vendors or materials, when provided in accordance with requirements of this Division, are approved for use. Materials supplied shall comply with specification requirements and be of a product of approved manufacturers. No deviations from this list shall be permitted unless specifically approved, in writing, after submission of satisfactory evidence relative to compliance with specification requirements.

1.06 ADDITIONAL WORK UNDER THIS SECTION

1. All existing sanitary and storm piping indicated on the plumbing drawings to be re-used shall be routed clean and inspected via camera probing system inside piping to determine condition and location prior to being re-used. Existing domestic water piping to remain to be visually inspected and if any problems report to engineer/architect.
2. Sawcutting, excavating, backfilling, compacting, rough patching, and prime painting shall be provided under this section. Coordinate requirements.

PART 2 - PRODUCTS

2.01 PIPE MATERIALS

1. Sanitary, waste, kitchen waste, vent, and storm piping above ground (up to and including 10" size) within building: Hubless cast iron pipe with no hub fittings CISPI301 and 4 & 6 band "Huskey Series 4000" clamps.

Manufacturers:           Charlotte Pipe  
                                  Tyler Pipe  
                                  ABI Foundry

2. Sanitary, waste, kitchen waste, vent, and storm piping below ground (all sizes and above slab over 10" size) within building: service weight cast iron pipe and fittings with hub and spigot ends, ASTM A74. Seal: one-piece neoprene rubber gaskets matching the internal configuration of the hub.  
  
Manufacturers:           Charlotte Pipe  
                                  Tyler Pipe  
                                  ABI Foundry
3. Indirect waste piping above ground: hard drawn seamless Type L, copper tubing ASTM B88 with wrought copper solder fittings ANSI B16.22 and "Bridgit" or other no lead content solder joints ASTM B32-83, alloy Grades SN96 or SB5. Solder flux lead content – zero percent.
4. Domestic hot and cold water piping underground (up to 2" size): Type K soft copper tubing ASTM B88 with Flared fittings for copper ASA A40.2, with ½" Armaflex SSA 2000 insulation. No joints are permitted below concrete slabs.
5. Fire protection water service piping above ground: Refer to Section 210000 for specification requirements.
6. Gas piping up to and including 2" size: shall be TracPipe Corrugated Stainless Steel Tubing (CSST) by Omegaflex, Inc. or pre-approved equal. Pressure carrier shall be series 300 stainless steel per ASTM A240; no annealing or heat-treating permitted after corrugating operation. Fittings shall be AutoFlare mechanical attachment fittings, material: yellow brass with series 300 stainless steel insert. Fittings shall terminate in cleanly cut taper pipe threads conforming to the Standard for Pipe Threads, General Purpose, ANSI/ASME B1.20.1. A flared metal-to-metal seat shall be used to accomplish gas sealing. No elastomer sealing rings or fiber gaskets permitted. Non-metallic jacket shall be colored yellow to visibly indicate conveyance of fuel gas. Jacket material shall be non-halogenated, fire-retardant polyethylene. Polyvinyl chloride (PVC) is not permitted. ASTM E84 Ratings shall be less than 14 for flame spread and smoke. Pipe installation requirements shall be per TracPipe Design and Installation Guide.
7. Gas piping (over 2" size): schedule 40 black steel ASTM A106, with schedule 40 but weld fittings.
8. Acid waste and vent piping shall be manufactured from Corzan® CPVC Type IV Grade I compounds, ASTM Cell Classification 23447 for fittings and 24448 for pipe. All pipe shall be schedule 40 dimensions per ASTM F441. All fittings shall be drainage pattern per ASTM D3311. One-Step solvent cement shall be specially formulated for chemical waste applications and conform to ASTM F493. All pipe, fittings and cement shall be supplied as a system by a single manufacturer and shall be certified by NSF International for use in corrosive waste drainage systems as a Special Engineered (SE) product and shall bear the NSF mark. Acid waste and vent piping shall be the ChemDrain™ system as manufactured by Charlotte Pipe and Foundry Co. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements.

9. Fire water service, domestic water service piping below ground (3" size and larger): Class 52 (exterior coated), cement lined ductile iron mechanical joint pipe, ANSI A21.51/AWWA C151 with 350 psi cement lined ductile iron mechanical joint fittings ANSI A21.10/AWWA C110 and ANSI A21.11/AWWA C111. Double cement lining on interior shall be in accordance with ANSI A21.4/AWWA C104. Provide and install tie-rods and clamps at each fitting. Coat rods and clamps, with an environmentally safe exterior corrosion protection coating. Provide thrust blocks at changes of direction.
10. Fire service piping (Interior) – Standard weight black steel (Schedule 40), seamless or welded mild steel ASTM A-135 or A-53 with welded fittings.
11. Compressed air piping above slab: Schedule 40 Black steel ASTM A106, threaded end ANSI B1.20.1 with class 150 malleable iron threaded fittings ANSI B16.3.
12. Radon piping: Schedule 40 PVC, Type DWV, ASTM D 2665, with chemically fused joints.
13. Underground gas service piping: plastic piping conforming with "standard specifications for thermoplastic gas pressure pipe, tubing, and fittings" ASTM D2513. Pipe shall be marked "GAS" and "ASTM D2513". Piping shall be installed in accordance with NFPA 54, and manufacturer's requirements.
14. Domestic hot water, cold water and hot water recirculating piping above ground.
  - a. **SUMMARY**
    - 1) Copper Tubing and Fitting System for Hot and Cold Water Distribution
    - 2) Systems, Sprinkler and Standpipe Systems and Hydronic Piping Systems
  - b. **DEFINITIONS**
    - 1) ASME: American Society of Mechanical Engineers
    - 2) ASTM: American Society for Testing and Materials
    - 3) EPDM: Ethylene-propylene-diene-monomer
    - 4) IAPMO: International Association of Plumbing & Mechanical Officials
    - 5) ICC: International Code Council
    - 6) MSS: Manufacturers Standardization Society
    - 7) AWWA: American Water Works Association
    - 8) NSF: National Sanitation Foundation
    - 9) UL: Underwriters Laboratory
    - 10) NFPA: National Fire Protection Association
    - 11) FM: Factory Mutual
  - c. **REFERENCES**
    - 1) ASME A13.1: Scheme for the Identification of Piping Systems
    - 2) ASME B1.20.1: Pipe Threads, General Purpose (inch)
    - 3) ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings
    - 4) ASME B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
    - 5) ASME B16.26: Cast Copper Alloy Fittings for Flared Copper Tube

- 6) ASME B31.9: Building Services Piping
- 7) ASTM B75: Standard Specification for Seamless Copper Tube
- 8) ASTM B88: Standard Specification for Seamless Copper Water Tube
- 9) ASTM B813: Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
- 10) ASTM B828: Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
- 11) AWWA C651: Standard for Disinfecting Water Mains
- 12) ICC: International Plumbing Code
- 13) ICC: International Mechanical Code
- 14) MSS-SP-58 Pipe Hangers and Supports Materials, Design and Manufacturer
- 15) MSS-SP-69 Pipe Hangers and Supports Selection and Application
- 16) NFPA 13 Standard for the Installation of Sprinkler Systems
- 17) NFPA 13D Standard for the Installation of Sprinkler Systems in One/Two Family Dwellings and Mobile Homes
- 18) NFPA 13R Standard for the Installation of Sprinkler Systems for Residential Occupancies up to and including Four Stories in Height
- 19) NFPA 14 Standard for the Installation of Standpipe and Hose Systems
- 20) NSF 61 Drinking Water System Components –Health Effects
- 21) NFPA 54 National Fuel Gas Code

d. **QUALITY ASSURANCE**

- 1) Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of ProPress copper press joint systems.
- 2) ProPress copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer.
- 3) The installation of copper tubing for hot and cold water distribution systems shall conform to the requirements of the ICC International Plumbing Code or IAPMO Uniform Plumbing Code.
- 4) The installation of copper tubing in sprinkler or standpipe systems shall conform to NFPA 13, 13D, 13R and 14.
- 5) The installation of copper tubing in Hydronic systems shall conform to the requirements of the ICC International Mechanical Code or the IAPMO Uniform Mechanical Code.
- 6) ASME Compliance: ASME B31.9 for building services piping valves.

e. **DELIVERY, STORAGE AND HANDLING**

- 1) Copper tubing shall be shipped to the job site on truck or in such a manner to protect the tubing. The tubing and fittings shall not be roughly handled during shipment. Tubing and fittings shall be unloaded with reasonable care.
- 2) Protect the stored product from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.
- 3) Protect fittings and piping specialties from moisture and dirt.

- f. **PROJECT CONDITIONS**
  - 1) Verify length of tubing required by field measurements.
  
- g. **WARRANTY**
  - 1) The tubing and fittings manufacturer shall warrant that the tubing and fittings are free from defects and conform to the designated standard. The warranty shall only be applicable to tubing and fittings installed in accordance with the manufacturer's installation instructions.
  - 2) The manufacturer of the fittings shall not be responsible for the improper use, handling or installation of the product.
  
- h. **MANUFACTURES**
  - 1) Press Fittings: Viega, 301 N. Main, Floor 9, Wichita, KS  
Telephone: (316) 425-7400, Website: [www.viega-na.com](http://www.viega-na.com).
  
- i. **MATERIAL**
  - 1) Tubing Standard: Copper tubing shall conform to ASTM B 75 or ASTM B88.
  - 2) Fitting Standard: Copper fittings shall conform to ASME B16.18, ASME B16.22 or ASME B16.26.
  - 3) Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect™) feature design (leakage path). In ProPress ½" to 4" dimensions the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
  - 4) Threaded Fittings: Pipe Threads shall conform to ASME B1.20.1.
  - 5) Hanger Standard: Hangers and supports shall conform to MSS-SP-58.
  
- j. **SOURCE QUALITY CONTROL (for FM approved projects see notation D)**
  - 1) All fittings in contact with drinking water shall be listed by a third party agency to NSF 61.
  - 2) All fittings used in Fuel Gas Applications shall be listed by a third party agency as being acceptable for fuel gas piping systems.
  - 3) All fittings used in Fire Sprinkler Applications shall be UL listed.
  - 4) All fittings used in Fire Sprinkler Applications shall be FM approved.
  
- k. **EXAMINATION**
  - 1) The installing contractor shall examine the copper tubing and fittings for defects, sand holes or cracks. There shall be no defects of the tubing or fittings. Any damaged tubing or fittings shall be rejected.

- 2) The installing contractor shall insure that sealing elements are properly in place and free from damage. For Sizes 2-1/2" to 4", installer should insure that the stainless steel grip ring is in place.

1. **PREPARATION**

- 1) Copper tubing shall be cut with a wheeled tubing cutter or approved copper tubing cutting tool. The tubing shall be cut square to permit proper joining with the fittings.
- 2) Remove scale, slag, dirt and debris from inside and outside of tubing and fittings before assembly. The tubing end shall be wiped clean and dry. The burrs on the tubing shall be reamed with a deburring or reaming tool.

m. **INSTALLATION GENERAL LOCATIONS**

- 1) Plans indicate general location and arrangement of piping systems. Identified locations and arrangements are used to size tubing and calculate friction loss, expansion, pump sizing and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

n. **INSTALLATION**

- 1) **Pressure Rating:** Install components having a pressure rating equal to or greater than the system operating pressure.
- 2) Install piping free of sags, bends and kinks.
- 3) **Change in Direction:** Install fittings for changes in direction and branch connections. Where approved, changes in direction may also be made by bending of Types K and L tube.
- 4) **Solder Joints:** Solder joints shall be made in accordance with ASTM B 828. The temperature of the joint during soldering shall not be raised above the maximum temperature limitation of the flux.
- 5) **Threaded Joints:** Threaded joints shall have pipe joint compound or Teflon tape applied to the male threads only. Tighten joint with a wrench and backup wrench as required.
- 6) **Flared Joints:** Flared copper tube joints shall be made by the appropriate use of cast copper alloy fittings. Flared ends of copper tube shall be of the 45-degree flare type and shall only be made with a flaring tool designed specifically for that purpose.
- 7) **Press connections:** Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.
- 8) **Pipe Protection:** Provide protection against abrasion where copper tubing is in contact with other building members by wrapping with an approved tape, pipe insulation or otherwise suitable method of isolation.



- 9) Penetration Protection: Provide allowance for thermal expansion and contraction of copper tubing passing through a wall, floor, ceiling or partition by wrapping with an approved tape or pipe insulation or by installing through an appropriately sized sleeve. Penetrations for fire resistant rated assemblies shall maintain the rating of the assembly.
- 10) Backfill Material: Backfill material shall not include any ashes, cinders, refuse, stones, boulders or other materials which can damage or break the tubing or promote corrosive action in any trench or excavation in which tubing is installed.
- 11) Horizontal Support: Install hangers for horizontal piping in accordance with MSS-SP-69 or the following maximum spacing and minimum rod sizes.
- 12) Vertical Support: Vertical copper tubing shall be supported at each floor.
- 13) Galvanic Corrosion: Hangers and supports shall be either copper or vinyl coated to prevent galvanic corrosion between the tubing and the supporting member.
- 14) Seismic Restraint: In seismic areas, copper tubing shall be installed to withstand all seismic forces.
- 15) Piping Identification: Copper tubing systems shall be identified in accordance with the requirements of ASME A13.1.

o. **FIELD QUALITY CONTROL**

- 1) Water Testing: The copper tubing system shall be water tested for joint tightness. The piping system shall be filled with water. The system shall be pressurized to the maximum pressure and length of time required by the code or standard. The system shall have no leaks at the rated pressure.
- 2) Air Testing: The copper tubing system shall be air tested for joint tightness. The piping system shall be pressurized with air to the maximum pressure of the system or to the code or standard required minimum for the required length of time. The system shall have no leaks at the rated pressure.

p. **CLEANING (potable water systems)**

- 1) Disinfection: The copper hot and cold water distribution system shall be disinfected prior to being placed in service. The system shall be disinfected in accordance with AWWA C651 or the following requirements:
  - a) The piping system shall be flushed with potable water until discolored water does not appear at any of the outlets.
  - b) The system shall be filled with a water chlorine solution containing at least 50 parts per million of chlorine. The system shall be valved off and allowed to stand for 24 hours or the system shall be filled with a water chlorine solution containing at least 200 parts per million of chlorine. The system shall be valved off and allowed to stand for 3 hours.
  - c) Following the standing time, the system shall be flushed with water until the chlorine is purged from the system.

2.02 PIPE HANGERS, SUPPORTS, SEISMIC RESTRAINT, AND VIBRATION ISOLATION

1. Pipe hangers and supports: Refer to Section 230523.
2. Seismic restraint: Refer to Section 230000 and Section 230548.
3. Vibration isolation: Refer to Section 230700.

2.03 INSULATION

1. Insulation: Refer to Section 230700. Existing piping to be re-used to be re-insulated after asbestos abatement.

2.04 VALVES

1. General: Refer to section 230523 for general plumbing service valves.
  - a. Domestic water systems up to 2-1/2"size: Nibco T-595-Y, 3 piece, full port, bronze threaded, 600 psi WOG.
  - b. Domestic water systems size 3" and over: Class 125, IBBM, gate valve.
  - c. Check valves for domestic water systems up to 2-1/2" size: class 125 all bronze, silent type, threaded.
  - d. Check valves for domestic water systems sizes 3" and over: class 125 IBBM flanged, silent check valve.
  - e. Balancing valve (domestic hot water circulation): All bronze, threaded end, calibrated stem, balancing ports, Armstrong CBVT series.
  - f. Fire Protection Water Service Valve - UL listed and FM approved, 6" grooved-end butterfly valve equipped with built-in tamper switch. Victaulic series 708-W.
2. Reduced pressure backflow preventers (rpz) - sizes 3/4" through 2": UL listed, AWWA, USC, and SBCCI/IAPMO approved bronze body reduced pressure zone air gap equipped with stainless steel relief and check valves, oversized copper funnel for pressure relief discharge piped to drain, bronze test cocks, integral body unions, bronze strainer and inlet and outlet ball valves. Manufacturer: Watts 909 series.
3. Fire Protection backflow preventer: UL/FM approved Watts 909DCDA doublecheck detector assembly 6" size.
4. Hose end drain valve NIBCO Fig. No. T-113-HC, all bronze gate (Watts #B-6000-cc, all bronze ball valve) with 3/4" hose thread outlet, threaded cap, rubber gasket and safety chain.

5. Gas service valves (exterior): UL listed, for gas service, lubricated, semi-steel plug type, 100% pipe area, with threaded end ANSI B16.10 for up to 2" size, and 125 lb. ANSI B16.1 flanged for sizes over 2", 200 psi WOG, Manufacturer Homestead 6111/612 series.

6. Domestic water reduced pressure zone backflow preventers (RPZ) – sizes 2-1/2" to 4": UL listed, AWWA, USC and SBCCI/IAPMO approved iron body reduced pressure zone air gap equipped with bronze relief and check valves, oversized copper funnel for pressure relief discharge piped to drain, bronze test cocks, complete with F.D.A. approved epoxy coated strainer and resilient wedge inlet and outlet gate valves.

Manufacturer: Watts 909 series  
Febco 825Y series.  
Zurn/Wilkins 975 series.

7. Gas pressure regulating valves: Pilot controlled, and actuated. Located at gas meter on site.

Manufacturer: Maxitrol RV series  
Rockwell 243-RPC series.

Gas Outlet Valve (GOV): Deck mounted single laboratory ball valve.

Manufacturer: Water Saver Faucet Co.  
Model #L4200-131WS

8. Air Admittance Valve (AAV/Chem Vent): Vent termination for individual vent.

Manufacturer: Studor, Inc., Mini-Vent.  
Item #20301 Chem-vent in labs

9. Emergency gas shut-off valve assembly (EGV)

a. Solenoid valve: UL listed, FM approved for gas service, explosion proof, two-way normally closed. Solenoid valve shall be compatible with specified Relay Panel, ASCO #8215, or as required.

b. Master control station: Provide one key-operated (reset), normally open switch and normally closed push button mounted on a common stainless steel face plate for flush installation. "Gas Valve Control" inscribed on the faceplate and switches labeled. Include 4-inch square wall box. Master control station: ASCO #216B89.

c. Auxiliary control stations: Provide auxiliary control stations, in addition to the master control station, where indicated on the drawings. ASCO#173A19.

d. Relay panel: UL listed relay panel circuit with control transformer, relay switch, and block terminal. Relay assembly housed in a NEMA 1, 16 gauge

flush wall cabinet with secured cover. Relay panel: ASCO 108D10C for valves up to 2"; ASCO 108D90C for valves over 2".

10. Water pressure regulating valve (PRV): the valve type shall be a fluid actuated pilot controlled pressure regulating valve equipped with a pressure sustaining feature that will cut out flow at a pre-set minimum pressure. The cut-off minimum pressure shall be set in the field after a documented flow test and water supply curve is performed and plotted. The valve shall incorporate:
  - a. Bronze Body
  - b. Sealed FDA approved elastomer diaphragm
  - c. Stainless steel spring and stem
  - d. Quad-ring flow throttling retainer
  - e. Brass hydraulic control pilots
  - f. Copper control tubing
  - g. Full size FDA approved strainer and blow down valve.
  - h. Inlet and outlet pressure gauges with bleed shut off valves on the gauge stem.

Manufacturer: Watts 115-2 series  
Watts Regulator Co. ACV Div., Houston, TX  
Cla-Val 92-01 series

#### 2.05 PIPE SLEEVES AND SEALS

1. Masonry walls and slabs: Schedule 40 galvanized steel pipe with integral water stop.
2. Piping seal: (interior walls contact with earth): interlocking expandable synthetic rubber links, assembled with corrosion resistant bolts, nuts and pressure plates; "Link type seal."
3. Piping seal: (interior floor slabs in contact with earth): seal between pipe and sleeve with a flexible elastomeric caulk listed specifically as a pipe sealant.
4. Sleeve adapters: coated cast iron, equipped with flashing clamp.
5. Fire and smoke seal: UL listed, approved and tested fire and/or smoke sealing material installed in all fire and/or smoke rated floor and partitions in accordance with manufacturer's recommendations. Refer to Section 230000.

#### 2.06 DRAINS

1. General:
  - a. Provide all poured in place drains with 24" x 24" vinyl flashing.
  - b. All sanitary drains to be provided with trap guard insert as manufactured by Proset in lieu of trap primers.

2. Floor drain toilet rooms and kitchens (FD): cast iron body, bottom outlet, 7" diameter nickel bronze top, trap primer connection, seepage pan and combination membrane flashing clamp.

Manufacturer:           Zurn ZN-415- type B strainer.  
                              Smith 2010.  
                              Wade 1100STD

3. Floor drain mechanical rooms (FD): heavy duty floor drain with, cast iron body, bottom outlet, 9" diameter cast iron top, trap primer connection, seepage pan and combination membrane flashing clamp, and funnel.

Manufacturer:           Zurn Z-508.  
                              Smith 2120.  
                              Wade 1310.

4. Roof drain (RD): heavy duty drain with, 15" diameter cast iron body, bottom outlet, 12" diameter cast iron dome, roof sump receiver, under-deck clamp, extension collar (as required), and combination membrane flashing clamp/gravel guard.

Manufacturer:           Zurn Z-100 series.  
                              Smith 1010 series.  
                              Wade 3000 series.

5. Floor Sink (FS): 8" square x 6" deep cast iron flanged receptor with acid resistant coated (ARC) interior, sediment bucket, 1/2" grate, seepage holes and flashing clamp.

Manufacturer:           J.R. Smith       3411Y  
                              Wade             9110  
                              Zurn             Z1910

6. Trench Drain (TD-ADA): Multiple section trench drain with bottom outlet, flange, extra heavy duty top with security screws. Grating shall be ADA compliant with spaces no greater than 1/2" wide. If grating has elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

Manufacturer:           Wade             2950 series  
                              Mifab            T1330-FL-4  
                              Zurn             Z866 series

7. Areaway drain (AD): Heavy duty drain with, cast iron body, bottom outlet, 12" x 12", bronze finish, seepage pan and combination membrane flashing clamp.

Manufacturer:           Josam 37810 series  
                              J. R. Smith  
                              Zurn

8. Overflow Roof Drain (ORD): Heavy duty drain with 15" diameter cast iron body, polyethylene dome, underdeck clamp, combination membrane flashing clamp/gravel guard with 2" high integral PVC standpipe.

Manufacturer: J. R. Smith 1070 series.  
Josam  
Zurn

9. Storm overflow nozzle: Stainless steel downspout cover with hinged strainer

Manufacturer: Zurn ZS-199-DC – sizes indicated on plan.  
J. R. Smith  
Josam

10. Shower Drain: Round top, cast iron body, adjustable strainer head.

Manufacturer: J. R. Smith Fig. 2005Y  
Josam  
Zurn

11. Downspout Boot (DB): Cast iron transition piece connecting exterior downspouts to cast iron piping in ceiling. 4" round, provide flashing.

Manufacturer: J.R. Smith 1787  
Josam  
Zurn

12. Roof Drain (RD2): Heavy duty drain with 15" diameter cast iron body, side outlet, 12" diameter cast iron dome roof sump receiver, under deck clamp, extension collar (as required) and combination membrane flashing clamp/gravel guard.

Manufacturer: J.R. Smith 1020Y  
Zurn Z100 Series  
Wade 3000 Series

## 2.07 CLEANOUTS

1. General: Provide all poured in place cleanouts with 24" x 24" vinyl flashing.

2. Floor cleanout (DPCO): areas incorporating floor finishes, adjustable round scoriated heavy duty nickel bronze secured top, cast iron body, flashing flange and clamp, tapered bronze plug.

Manufacturer: Zurn ZN-1400 series.  
Smith 4020 series.  
Wade 6000Z series.

3. Floor cleanout (DPCO): exposed concrete floor areas, adjustable round scoriated heavy duty cast iron secured top, cast iron body, flashing flange and clamp, tapered bronze plug.

Manufacturer: Zurn Z-1400 series.  
Smith 4020 series.  
Wade 6000Z series.

4. Floor cleanout (DPCO): carpeted areas, adjustable round scoriated heavy duty nickel bronze secured top, carpet marker, cast iron body, flashing flange and clamp, tapered bronze plug.

Manufacturer:           Zurn ZN-1400 series.  
                              Smith 4020 series.  
                              Wade 6000 series.

5. Wall plate cleanout cover (WPCO): provided at cast iron cleanouts with tapered bronze plug a 6" x 6" chrome/nickel plated bronze square frame and plate secured with vandal proof screws.

Manufacturer:           Zurn ZANB-1460 series.  
                              Smith 4730 series.  
                              Wade 8480ST series.

2.08 PLUMBING FIXTURES – note that fixture types indicated are subject to change as they are selected by Architect. Fixture types are indicated here only to establish a general level of quality.

1. Fixtures: new, complete with trimmings and fittings, including faucets, carriers, supplies, stops, traps, tailpieces, waste plugs, casings, hangers, plates, brackets, anchors, supports, hardware and fastening devices.

2. Stainless steel: Type 302, 304, 316, or 317, as noted, sound deadened.

3. Trimmings and fittings: construct of forged, cast, rolled or extruded brass or bronze with monel and other suitable non-corrosive parts: designed with easily renewable parts that are subject to wear or deterioration. No die castings and stampings other than brass or stainless steel. Plumbing trim shall consist of:

Exposed surfaces:       chrome plated.  
Pipe:                     copper type L.  
Pipe fittings:           threaded bronze.  
Supply stops:           chrome plated bronze, stuffing box, renewable seat washer.  
Waste tailpiece:        minimum #17 gauge brass.  
Escutcheons:            one-piece chrome plated cast brass or stainless steel.

4. Water closets (WC and HC WC): flush valve, standard and handicapped (ADA compliant), vitreous china, wall hung, 1.5 gpf low flow, elongated, siphon jet, with 1-1/2" top spud. Seat: heavy-duty solid plastic elongated open front complete with flush valve (include trap primer on 1 flush valve in each toilet room equipped with floor drain) combined and concealed carrier and support with heavy duty EPDM gasketing. Color: white. Provide (2) extra water closets to the owner and all listed components of 2.8 D for educational purposes. They will be used for the student plumbing shop.

Fixture:                    American Standard "Afwall" 2257.103.  
                              Kohler "Kingston lite" K-4330.  
                              Eljer "Auburn" 111-1505.

Seat: Church #9500C.  
Olsonite #95.

Flush valve: Optima 111 ES-S or pre-approved equal.  
Zurn Z-6000-WS-1 series.  
Delany 402-1 series.

5. Urinal (UR, HC UR): standard and handicapped (ADA compliant), vitreous china, wall hung, 1.0 gpf low flow, washout, with 3/4" top spud complete with Flush Valve. Concealed carrier support. Color: white. Provide (2) extra urinals to the owner and all listed components of 2.8 E for educational purposes. They will be used for the student plumbing shop.

Fixture: American Standard "Washbrook" 6501.010.  
Kohler "Bardon Lite" K-4960-T.  
Eljer "Correcto" 161-1030.

Flush valve: Sloan Royal Optima 186 ES-S or pre-approved equal.  
Zurn  
Delany

6. Wall hung lavatories (LAV), (HC LAV): vitreous china, standard and handicapped (ADA compliant), 20-1/2" x 18-1/4" x 6-1/2" deep, concealed arm carrier, drilled for 4" O.C. faucet, 1-1/2" chrome plated cast brass P trap with cleanout plug, chrome plated brass angle stops with loose key operator, grid drain and tailpiece. Insulate trap and hot water and cold piping below handicap lav with insulation kit. Color: white. HC rim height 34", knee clearance 27"H, 30"W, 19"Deep. Provide (2) extra wall hung lavatories to the owner and all listed components of 2.8 F for educational purposes. They will be used for the student plumbing shop.

Fixture: American Standard "Lucerne" 0356.041.  
Kohler  
Eljer

Faucet: Sloan ETF-80-P-BDT with mixing valve and transformer.  
(electric sensor)  
Symmons  
Delta

Insulation: TRUEBRO Model 101  
McGuire Pro Wrap  
HW & Drain pipes under HC Lav.

7. Single compartment sink (S1) (HC S1)(HC AS2): standard, single compartment 25" x 21" x 6" deep, left or right offset drain, 18 gauge, type 302 stainless steel, self-rimming sink with (3) hole rear deck, 2-piece strainer assembly and tailpiece, 1-1/2" chrome plated cast brass P-trap with cleanout plug, chrome plated brass angle stops with loose



key operator. Chrome plated brass single lever faucet. Provide chrome plated brass cover for third sink hole on rear ledge. 6" bowl depth. HC rim height 34", knee clearance 27"H, 30"W, 19"Deep. ADA compliant.

Fixture: Elkay LRAD-2521. L or R  
Just  
Dayton

Drain: Elkay LK-35

Faucet: Delta 710 WFHDF  
Symmons  
Moen

Insulation: TRUEBRO Model 101  
McGuire Pro Wrap  
HW & Drain pipes under HC S1 & AS2

Mop receptors (MR): 24" x 24" x 12" deep, terrazzo basin drain fitting and strainer, edge guard. Faucet: Wall mounted with bucket hook, vacuum breaker and wall bracket and hose thread end. Hose and bracket and mop hanger.

Fixture: Fiat TST-100 series  
Stern Williams SB-900 series  
Florestone Model 80 series

Faucet: Chicago 897 series  
T&S B-66655-BSTR series

Accessories: Hose Fiat 832-AA, mop hanger Fiat 899-CC, bumper guard  
Fiat 1239-BB, and strainer Fiat 1453-BB

8. Salon Sink (S2): Porcelain enamel cast iron shampoo bowl complete with vacuum breakers, fixture, sprayer and strainer. 1-1/2" chrome plated cast P-trap with cleanout plug. Chrome plated brass angle stops with loose key operator. Color by architect.

Manufacturer: Belvedere 3100 Cameo Bowl.  
or pre-approved equal

Hair Interceptor: Zurn Z1175  
J.R. Smith  
Josam

9. Electric Water Cooler Wall-mounted (HC DF2): Self-contained, electric refrigerated wall-mounted water cooler. ADA compliant, NSF/ANSI 62 certified and meet the requirements of the Safe Drinking Water Act. Unit provides 8 gph of 50°F water at 90°F ambient and 80°F inlet water. Provide water filter accessory, selected by Architect. Remote Chiller: Halsey Taylor SJ5-Q. Drinking Fountain Locker Rooms (HC DF): Halsey Taylor HAC8FS-WF-QSS ADA Compliant.

Manufacturer: Halsey Taylor HTV8-Q  
Elkay  
Sunroc

10. Electric water cooler – recessed (HC DF): ADA compliant oval shape B1-level, stainless steel fountain with integral chiller recessed in wall.

Manufacturer: Halsey Taylor OVL-II series bi-level SER-Q  
Elkay  
Sunroc

11. Shower Valve (SH, HC SH): Symmons Model 96-500-B30-X-L-V Temptrol 2000 pressure balancing valve with lever handle, internal volume control and stops, wall/hand shower with 5' metal hose, wall connection and flange, 30" slide bar and inline vacuum breaker, diverter with volume control and shower head with arm and flange. ADA compliant.

Manufacturer: Symmons  
Speakman  
Moen

Shower Valve: Symmons Model 96-1-X Temptrol Mixing Valve with shower head.

Shower Floor: Swanstone Model STS-3738, size 37" x 38". Color – Swanstone with 1/2" curb. ADA Complaint

12. Handicap Accessible Eye Wash/Shower Combinations (HC ESC)

Handicap Accessible Emergency Eye Wash/Shower Combination  
HAWS Model 8320CRP with 10" diameter polished stainless steel head and piping. Extra long ADA compliant, 48" max. above floor, pull down spreader rod attached to a stainless steel stay open ball valve. Emergency sign. ADA compliant.

Manufacturer: Haws  
Fischer Hamilton  
Speakman

Provide thermostatic mixing valve: Lawler 911E with cabinet

13. Three Compartment LAV (HC LAV3): Three person wash basin, ADA Compliant, Polyester resin bowl and pedestal, infrared sensors with stainless steel spray heads, thermostatic mixing valve. Set at 105°F, checkstop and strainer assemblies in stainless steel bottom enclosure with soap dispenser. Plug in transformer.

Manufacturer: Acorn 3793-SO-DV-MXT  
Willoughby WAW-2333  
Bradley

Two compartment LAV (HC LAV2): Similar to 3

Manufacturer: Acorn 3792-SO-DV-MXT  
Willoughby WAW-2322  
Bradley

14. Lab Sink (LS-ANT): Epoxy Resin Single Basin Drop-In Sink, 24" x 16" x 6" deep. ADA compliant. Complete with strainer, P-trap and overflow. Chrome plated, brass angle stops with loose key operator. Add acid tank and vac. breakers. HC rim height 34", knee clearance 27"H, 30"W, 19"Deep

Manufacturer: Sheldon Laboratory Systems  
or pre-approved equal.

Faucet: Sheldon Labs Unimix Hot & Cold Water Only

Insulation: PROVIDE Truebro Insulation Kit on all handicap sinks.  
HW & Drain pipes under Handicapped

Point of Use Acid  
Neutralizing Tank: Orion Style 8 Point of Use 1-1/2 gallons

15. Art Room Sink (AS): Just Mfg. Model NSFB-172, 72" L x 14" W x 12" Deep  
One compartment stainless steel sink on legs with backsplash.  
(2) 8" o.c. holes

Manufacturer: Elkay  
Just  
Dayton

Faucet: (2) Elkay Model LK940AT08L2H 8" o.c.

16. Insulation Kit: Truebro insulation kit models 102W & 105W  
Install on all handicapped sinks

17. Solids Interceptor (SI): Cast aluminum body with sediment bucket and removable stainless steel screens. Install where indicated on plans.

Manufacturer: Wade 5730  
J.R. Smith 8760  
Zurn Z1176

18. Scrub Sinks: Three station stainless steel sinks with sensor operated goose neck faucets, thermostatic mixing valves.

Manufacturer: Acorn 4103-MC-PDM-SA.  
Future Health Concepts FHC 5596  
Skytron

19. Hand Sink (Food Service): Eagle Group #HSA-10-FDP complete with splash mount gooseneck faucet, C-fold towel dispenser, soap dispenser and basket drain. Provide point of use thermostatic mixing valve (TV) on 140°F hot water supply. (Lawler #TMM1000)

Manufacturer: Eagle  
Elkay  
Just

20. Wash fountain (HC WF): ADA compliant. Polyester resin bowl and pedestal, 4 station, stainless steel spray heads with infrared sensors, thermostatic mixing valve, checks, stops, strainers and flexible stainless steel supply hoses. 3/8" solenoids, plug in transformer. ADA rim height 34".

Manufacturer: Willoughby WAF - 4400  
Bradley MF-2944  
Acorn

21. Free-standing stainless steel sink (S3): Just mfg. Model NSFB-124 24" x 27" x 12" deep. One compartment stainless steel sink on legs with back splash.

Manufacturer: Elkay  
Just  
Dayton  
Faucet: Elkay LK940AT08L2H 8" o.c.

22. Temporary Surgical Sink (S4): Just Mfg. NSFB – 248 48" x 24" x 12" deep. Two compartment stainless steel sink and legs with backsplash.

Manufacturer: Elkay  
Just  
Dayton  
Faucet: Elkay LK940AT08L2H 8" o.c.

23. Watercloset (2) for student plumbing shop: floor mounted, flush tank, standard, vitreous china, 1.5 gpf low flow, elongated, pressure assisted siphon jet with chrome plated trip lever. Seat heavy duty solid plastic open front, chrome plated brass angle supply with loose key stop.

Fixture: American Standard "Cadet" 2292.100  
Kohler "Wellworth" K-3458  
Eljer "Preserver II" 091-4855 (gravity fed)  
Seat: Olsonite 95  
Church 9500C

2.09 WATER HEATING EQUIPMENT

1. General: Water heaters shall conform to all applicable A.S.M.E. Standards and if gas fired Design Certified by the A.G.A. under Volume II "Tests for Commercial Heaters for Delivery of 140 Degrees F. Water", approved by the National Sanitation Foundation, and in compliance with ASHRAE 90 (latest edition).
2. Water Heaters WH#1 and WH#2: P.V.I. model 800 P 250A-PV Power VT gas, vertical, single module, 250 gal. tank. Interior of tank shall be coated with polyshield. Units shall be complete with all standard equipment including P & T relief valve, drain valve, and warranty. Heater shall be capable of heating 800 gallons per hour at 100 degrees Fahrenheit temperature rise with 565,000 BTU's per hour ea. propane gas.

Manufacturers: PVI  
Aerco  
Fulton

3. Water Heaters WH#3 and WH#4 (Food Service): P.V.I. model 800 P 125A-PV Power VT, 565,000 BTU, 640 GPH@100°F temperature rise ea. 125 Gallon Capacity. Blower motor, circ. pump, gas train and air pump to be removed for installation.

Manufacturers: PVI  
Aerco  
Fulton

4. Domestic Water Blending Valve: All bronze thermostatic type and threaded connections.

Manufacturer: Lawler Model 802  
Symmons  
Leonard

2.10 PUMPS

1. Domestic hot water circulating pumps: UL listed, all bronze, in-line centrifugal pump, close coupled.

Manufacturer: Bell & Gossett PR series, 1/6 hp, 120V, 1 phase.

2. Circulator controllers: UL listed, automatic immersion aquastat, adjustable temperature range, and differential immersion well. Electrical rating 115 VAC.

Manufacturer: Honeywell L4006A.

3. Motor starters: UL listed, manual starting switch in NEMA 1 enclosure with "Hands-Off-Auto" selector switch. Refer to section 230513.

4. Air Compressors:

- a. In Garage B140 serving carpentry, electrical and plumbing shops shall be duplex 15 hp compressors mounted on 120 gallon receiver tank with control panel and desiccant dryer. Unit shall be capable of delivering 55 cfm @ 120 psi. 230v, 3ph.

Manufacturer: Ingersoll Rand UP6-15C-125/120-230-3  
Air Dryer: Ingersoll Rand Drystar DS75

- b. On Equipment Platform B206 serving manufacturing shop shall be a 15 hp compressor mounted on 120 gallon receiver tank with integrated air dryer and control panel. Unit shall be capable of delivering 50 cfm @ 120 psi. 200v, 3ph.

Manufacturer: Ingersoll Rand UP6-15CTAS-150/120-200-3

- c. In Equipment Storage Room G107 serving auto shop shall be duplex 10 hp compressors mounted on 200 gallon receiver tank with control panel and desiccant dryer. Unit shall be capable of delivering 68 cfm @ 120 psi. 230v, 3ph. Control panel located remotely in auto shop.

Manufacturer: Saylor Beall X-755-200

5. Duplex Sump Pumps (SP1):

- a. Pumps: Goulds model 3885, Series WE0318M 1/3 HP, 208V, 1ph, 60CY, 1750 RPM, UL listed, submersible non-clog pumps with cast iron body, cast iron impeller, sealed oil-filled motor, stainless steel shaft, ceramic/carbon seal, heavy duty upper and lower ball bearings, sealed power cord and 2" threaded discharge. Capacity: 25 gpm at 20Ft. TDH.
- b. Controls: Goulds model A6-2012, automatic duplex control system panel with NEMA 1 steel enclosure, circuit breakers, magnetic starters, alternator circuit, run indicator lights, H.O.A. switches, terminal blocks and high water alarm circuit with alarm bell, indicator light and silencing switch. Provide with four N.O. mechanical tilt float switches for off, lead, lag and high water alarm sequencing Warrick series M-BLU-20 provide tether tie-down and weight and an extra set of dry contacts for remote annunciation. Provide float switch mounting bracket Model FSB1.

6. PIT Covers: Federal style PF-1 square angle iron pit frame and steel cover, gas-tight, drilled for control wiring, 2" discharge and 3" vent connections. Coordinate cover size with size of pits.

7. Sump Pump (SP-2): Simplex Pump in basin. 1/2 HP, 110V, 1 ph.  
Manufacturer: Little Giant 105 series.

2.11 INTERCEPTORS

1. Grease Interceptor

- a. Proceptor Model GMC 2000 grease and solids interceptor having a capacity of 2000 US gallons, or a pre-approved equal. The interceptor shall have a grease storage capacity of 1025 US gallons and a solids storage capacity of 850US gallons.
- b. The interceptor shall be designed to remove from process wastewater grease and other floatable material(s). The Proceptor model shall be designed to treat commercial effluent as a maximum gravity flow rate of 200 usgpm. The effluent shall have no degreasers, surfactants, or emulsifiers. The Proceptor system shall provide adequate treatment time to limit effluent discharge levels of non-emulsified solvent extractable matter of animal or vegetable origin to 100 PPM and total suspended solids (TSS) to 350 ppm.
- c. The interceptor shall minimize turbulence, promote centrifugal separation and settling and prevent re-suspension and scouring of collected materials. Temporary backwater conditions shall not cause trapped contaminants to be re-suspended or scoured from the interceptor. Each interceptor shall comprise two cells or chambers of circular cross section in the horizontal plane, providing integral baffling. Wastewater shall enter below the normal liquid level and tangential to the interceptor wall. The manufacturer shall provide each interceptor with cleanout, sample, and ventilation ports together with an extension collar and frame and cover to allow access for removal of grease and solids.
- d. The interceptor shall be of glass-fiber construction using a thixotropic polyester resin specifically for the manufacture of reinforced products. The resulting material shall be inert, non-corrosive and impervious to retained wastes. The interceptor shall be suitable for underground installation in a non traffic area with a concrete hold down pad and the rods and brackets. Provide vents and access covers and installed as per the manufacturer's recommendations.

Manufacturer: Proceptor  
Containment Solutions  
Xerxes, Inc.

2. Oil Interceptor

- a. Proceptor Model OMC-1000 or pre-approved equal. The separator shall be designed to remove from process wastewater oil and other floatable material(s), and sediment, sand and other settleable material(s). The effluent shall have no degreasers, surfactants, or emulsifiers. The Proceptor™ system shall provide adequate treatment time to limit effluent discharge levels of non-emulsified solvent extractable matter of mineral or synthetic origin to a maximum of 10 ppm and total suspended solids (TSS) to a maximum of 350 ppm to avoid penalties and retrofit as enforced by local pretreatment officials.

Manufacturer: Proceptor  
Containment Solutions  
Xerxes, Inc.

2.12 MISCELLANEOUS PLUMBING SPECIALTIES

1. Mechanical mixing valves (kitchen hand sink): bronze body, chrome plated, 3/8" inlet and outlet connections.

Manufacturer: Lawler Model 526  
Symmons #4-10 series  
Leonard

2. Water hammer arrestors: all stainless steel, mechanical-pneumatic type, hermetically sealed bellows, threaded inlet; 150 psi WWP. Use in lieu of air chambers on all supplies to fixtures.

Manufacturer: Watts SG series.  
PPP SC Series  
Josam

3. Air vent: bronze body, stainless steel trim and float, threaded inlet and outlet; 150 psi WWP.

Manufacturer: Sarco 13W series or pre-approved equal.

4. Pressure gauge - PG: direct mounting, liquid filled, constructed with non-corrosive internal mechanism, recalibrator adjustment, assembled on 4-1/2" black phenolic turret type case with blow out plug, gasket sealed glass faced with dial, 0 to 200 psig range. Gauge accurate to 1% of scale range.

Manufacturer: Terice 450LFB series or pre-approved equal.

1. Gauge valve: all bronze needle valve, 150 psi WWP.

5. Water Filter Scale Inhibitor: scale inhibitor water conditioner, constructed of high impact strength plastic for 125 psi WWP, equipped with integral by-pass and replaceable cartridge filter element, 1 to 6 gpm flow range. Equip on cold water make-up supply to all HVAC equip.

Manufacturer: Filterite SI-4 series or pre-approved equal.

6. Vacuum beaker (non-pressure type): brass body, silicone disc. To be used on lab & food service sinks.

Manufacturer: Watts 288 series.  
Febco  
T & S

7. Freeze proof hose bibb (FPHB): surface mounted wall hydrant with polished bronze face plate and bronze casing with "T" handle key and internal vacuum breaker. Size 3/4".

Manufacturer: Zurn Z-1310 series.  
Smith 5609 series.  
Wade 8600 series.

Hot & cold water FPHB: J.R. Smith 5560QT or pre-approved equal.



8. Hose bibb (HB): unfinished areas, bronze body, removable valve seat and stem assembly, threaded end and Watts NF8 vacuum breaker.  
Manufacturer: Nibco #64 with Watts NF8 series or pre-approved equal.
9. Acid neutralization tank (ANT): Point of Use, 1-1/2 gallon capacity  
Manufacturer: Orion Style 8, or pre-approved equal  
PHIX Cartridge System  
(provide media as required)
10. Expansion Tank: Precharged diaphragm-type vessel. 125 PSI, 240<sup>o</sup>F. 30 gallons.  
Manufacturer: Bell & Gosset Model D-60V, or pre-approved equal
11. Compressed air quick connect couplings: Brass coupling.  
Manufacturer: Rectus 14 KA series or pre-approved equal .
12. Air hose reel: Retractable air hose reel, spring loaded, corrosion resistant housing, 50 ft of 3/2" PVC hose with fitting, 12 month warranty.  
Manufacturer: Reelworks Model #L816153-P  
Install per manufacturer's instructions.
13. Expansion Joints: Fabricated weld on ends with limit rods, double end. Constructed of stainless steel.  
Expansion Joints (water piping):  
Manufacturer: JCM Industries JCM802 or pre-approved equal,  
Expansion Joints (no-hub storm and sanitary):  
Manufacturer: Wade 3900 NH, or pre-approved equal
14. Waste oil collection tank – 275 gallons standard residential type steel tank with funnel to inlet. Weather proof exterior coated. Secondary storage required.  
Manufacturer: Granby tanks or pre-approved equal.

#### 2.13 ACCESS DOORS IN WALLS AND CEILINGS

1. At each valve, cleanout or plumbing device requiring access, furnish an access door for installation by other sections. Rigid construction with two hinges and a latch. In plenum ceilings, provide felt between the door and frame to make an airtight seal. Panels/doors shall be flush mounted, prime coated with rust inhibitive paint, concealed frame, flush screwdriver operated locks with metal cams and anchors as required. Refer to division 8 for additional requirements.

Access door sizes shall be:  
12" X 12" at easily accessible items.  
16" X 16" where partial body access is required.  
24" X 24" where full body access is required.

Manufacturer: Milcor type M series.  
Cesco series.  
or pre-approved equal

#### 2.14 TRACERS FOR FREEZE PROTECTION

1. To be provided on all new outdoor piping. (2) 16 AWG copper bus wires embedded in parallel in a self regulating polymer core that varies its power output to respond to temperature along its length. The system shall permit crossing of cable without overheating. The heater cable shall be covered by a radiation cross linked modified polyolefin dielectric jacket.
2. All components shall be U.L. listed. See Electrical Drawings for location.
3. Rating: Adequate to maintain minimum 40°F in lines protected.
4. Cable manufacturer: Raychem XL-Trace or the pre-approved equal of Chemelx.
5. Control: The heater cable shall have a self-regulating turn down factor of 90%.
6. Thermostat manufacturer: Chromalox Type PIT-15 raintight thermostat.
7. Form a loop and wrap tracer cable around piping, fittings and valves according to manufacturer's recommendations with the following required length of cable allowed for each size gate/globe valve or strainer as listed.

1" valve = 3'-0" tracer cable  
4" valve = 8'-0" tracer cable  
8" valve = 15'-0" tracer cable

##### Minimum watt density

<3":	5.0 watts/ft.
4":	5.0 watts/ft.
6":	8.0 watts/ft.
8":	(2) @ 5.0 watts/ft.
up to 14":	(2) @ 8.0 watts/ft.

For further installation details of cable and controls refer to manufacturer's recommendations

**PART 3 - EXECUTION**

**3.01 GENERAL**

1. Drawings are diagrammatic and indicate a general arrangement of work. General design concepts indicated must be followed or bettered. Do not scale drawings. Consult Architectural and Structural drawings for space conditions. Develop and submit coordination drawings as outlined in Section 230000.
2. Manufacturer's qualifications: firms regularly engaged in the manufacturer of fixtures, appliances, pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
3. Material qualifications: shall conform to all local, state, and national/federal codes and regulations which may apply and nothing in these specifications shall be interpreted as an infringement of such codes or regulations.
4. Welding: qualify welding procedures, welders, and operators in accordance with ASME B31.1, or ASME B31.9, as applicable. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).
5. Brazing: certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

**3.02 DELIVERY, STORAGE, AND HANDLING**

1. Except for concrete, corrugated metal, hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling, as required to prevent pipe-end damage, and eliminate dirt and moisture from inside of pipe and tube.
2. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.
3. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

**3.03 ELECTRICAL CONNECTIONS AND WIRING**

1. Power wiring to electrical devices shall be installed by Division 16. The Plumbing Contractor shall be responsible to furnish all motor starters for installation by Division 16 and provide and install miscellaneous control and power wiring required by the equipment for proper and safe operation not specifically outlined in Division 16.

3.04 EQUIPMENT IN OTHER DIVISIONS AND/OR BY THE OTHERS

1. Kitchen equipment shall be provided, set, assembled, and installed by Kitchen, Laboratory, Laundry, and Darkroom Contractor, except as noted below or on drawing.
2. Faucets and tailpieces and laboratory fittings shall be provided and set by other divisions. Piping connections shall be provided by Section 220000.
3. Section 220000 shall provide and/or install traps, stops, faucets, fittings, tailpieces, including any miscellaneous trim and/or components not furnished by others but required for safe and proper operation, and connect the service.
4. Obtain certified and approved prints of roughing drawings of equipment before starting work.
5. Coordinate and verify all equipment locations, connections, and equipment requirements with the Kitchen Contractor. Provide and install all piping and equipment necessary to operate all equipment properly and safely whether specifically shown or not.
6. All exposed piping, stops, cocks, and wastes which are visible to occupants shall be chrome plated.
7. Install gas piping, and gas piping specialties in accordance with NFPA 54, NFPA 58, and authorities having jurisdiction.

3.05 COORDINATION OF WORK

1. Carefully coordinate space requirements with other trades to insure that all materials can be installed in spaces allotted thereto, including finished suspended ceilings.
2. Prepare and submit coordination drawings as outlined in section 230000.
3. Provide and install concrete housekeeping pads for all floor mounted plumbing equipment.

3.06 PIPING GENERAL

1. The word "piping" in this Specification shall mean pipe, fitting, flanges, nipples, and valves. Install underground piping as soon as possible so that trenches may be closed as quickly as possible.
2. No piping shall be covered until tested approved by the Authorities having jurisdiction.
3. Install all piping in correct relation thereto and the finished grades indicated on the drawings, and as required for coordination.
4. All piping shall be run perpendicular and/or parallel to floors, interior walls, etc. Piping and valves shall be grouped neatly and shall be run as to maximize headroom or passage clearance. All valves, controls and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.

5. All pipe lines made with screwed fittings must be provided with a sufficient number of flanges and/or unions to allow for easy and convenient dismantling of the system without breaking fittings.
6. Check the drawings for space limitations permitted for the installation of piping such as shafts, chases, and furred ceilings.
7. All piping shall run concealed in furred spaces of occupied areas or chases wherever construction permits. Contractor shall obtain permission from the Contracting Officer to run any exposed pipes.
8. All pipes shall be reamed to full area before installation and blown clear of chips and dirt. With threaded pipes apply compound to the male thread only.
9. Cap all pipe and equipment outlets during construction and keep lines and inside of equipment free of foreign materials. Provide for expansion without warping or dislocating lines or straining connected equipment. Install piping to clear building construction and to avoid interference with other work.
10. Provide and erect in a workmanlike manner, according to the best practices of the trade, all piping shown on the drawings or required to complete the installation intended by these specifications.
11. The drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset as required to meet field conditions.
12. This Contractor shall inform himself from the general construction specifications and plans, of the exact dimension of finished work and of the height of finished ceilings in all rooms where equipment or pipes are to be placed and arrange his work in accordance with the schedule of interior finishes, as indicated on the architectural drawings.
13. All piping below grade or building slab shall be coated with coal tar enamel.
14. Provide and install identification of piping and valves. Refer to other Division 23 Sections for installation requirements.
15. Provide and install additional pipe protection (ie. concrete encasement, and /or laying condition, bedding type and methods...) for underground piping subject to excessive loading by depth of bury, traffic or other sources.

### 3.07 PRESSURIZED PIPING

1. Exterior water piping shall be installed at least 5'-0" below grade to top of pipe.
2. Water piping shall be run free of traps and unnecessary bends. Any traps formed shall be provided with hose end drain valves with threaded cap and chain to completely drain the system.

3. Install water hammer arrestors on water systems in accordance with manufacturer's recommendations.
4. Provide section cut-off valves on all main branches or as shown. Pitch and valve all water piping for convenient drainage.
5. Wherever dissimilar metals are joined together an approved dielectric fitting shall be used.
6. Each sectional shut-off shall have a brass tag and copper wire with a number. A chart shall be made up for each system setting forth the number of valves and what fixture it controls. Chart to be placed in glass frame and hung in Mechanical Equipment Room. Refer to Section 230000 for piping and valve identification requirements.
7. Balance domestic hot water recirculation systems to maintain temperature throughout entire system.

### 3.08 DRAINAGE PIPE INSTALLATION

1. Run all soil, waste and vent piping shown or required by local codes. Piping shown is minimum and in accordance with State and Federal codes. If local codes require additional venting or larger sizes, same shall take precedence.
2. Make all connections through traps. Each trap to be vented, either by circuit, loop, or individual vent, as required, but not less than shown, or as required by local code.
3. Install exterior underground sanitary and storm drainage piping at least 48 inches below grade to top of pipe unless otherwise specifically indicated.
4. Vent pipes shall be graded to free themselves of any water or condensation. Pitch vents not less than 1/8" per foot up toward stack.
5. Install exterior cleanouts with an 18" square x 6" thick concrete apron.
6. Pitch horizontal storm water and drains within or buried under the building not less than 1/8" per foot unless otherwise indicated on drawings.
7. Pitch horizontal sanitary and waste piping at 1/2" per ft. slope for piping 1-1/2" or less; 1/4" per ft. slope for piping 2" diameter; and 1/8" per ft. slope for piping 3" to 6" diameter.
8. Piping shall be laid true to line and grade as shown on the drawings, and in such a manner that a true and even surface at the invert is made over joints and throughout the entire length of the line. Piping shall be graded by the tripod level and measuring rod method assuring a uniform slope of the pipe.

9. All underground piping shall be laid on 6" sand and backfilled with clean fine earth compacted to 12" above pipe. Complete backfill with available earth free of large boulders and sharp rocks. Tamp backfill in 6" elevations and overfill to allow for settlement.

### 3.09 PIPING SUPPORT

1. General
  - a. Refer to Sections 230000, 230523, and 232000 for general requirements.
  - b. Protection shields shall be provided under all horizontally insulated piping at each hanger.
  - c. Provide necessary structural members, hangers and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations.
2. Horizontal piping support
  - a. Cast iron soil pipe shall be supported at not more than 5-foot intervals. Supports shall be of ferrous material.
  - b. Copper tubing shall be supported at approximately 6-foot intervals for piping 1-1/2" and smaller and 10-foot intervals for piping 2" and larger. Supports shall be of copper material.
3. Vertical piping support
  - a. Cast-iron soil pipe. Cast iron soil pipe shall be supported at not less than every story height and at its base. Supports shall be of ferrous material.
  - b. Bases of cast iron soil stacks shall be supported on concrete, or metal brackets attached to the building structure, or any other methods designed to eliminate stress at the base of stacks and leaders approved by the local administrative authority.
  - c. Copper tubing shall be supported at each story for piping 1-1/2" and over and not more than 4-foot intervals for piping 1-1/4" and smaller. Supports shall be of copper material.

### 3.10 INSULATION

1. Refer to section 230700 for installation requirements.

### 3.11 VALVES INSTALLATION

1. Refer to section 230523 for general requirements.

2. Do not install air gap backflow preventers in concealed spaces or in areas where splashing water will damage finishes. Provide and install an oversized copper funnel with air gap directly below RPD pressure relief port. Pipe funnel to spill as an indirect waste to an approved drain location.
3. Install all trap primer valves in an accessible location. Provide and install access panels and doors where required to gain access in concealed construction.

### 3.12 SLEEVE INSTALLATION

1. Refer to Section 230000 and 230523 for general requirements.
2. All piping through walls, floors or ceilings shall have sleeves and escutcheons.
3. All piping penetrating a slab on grade or foundation wall below grade and in contact with earth shall be provided with a poured in place schedule 80 galvanized steel water tight sleeve with integral water stop and seal equal to "link seal".
4. Furnish and set steel pipe sleeves of schedule 40 black steel for all locations of interior partitions, walls and floors providing at least 1/2" clearance between pipe insulation and sleeve or pipe and sleeve. Wall sleeves shall be smooth cut and set flush with finished walls. Floor sleeves shall extended 2" above the finished floor. Provide a two-piece chrome escutcheon where piping passes through walls or floors of finished spaces.
5. Fill void spaces between piping and pipe sleeves penetrating fire/smoke walls and floors with an approved UL listed and fire tested sealing material.

### 3.13 DRAIN AND CLEANOUT INSTALLATION

1. General: Provide and install all drains and cleanouts with 6# 24" x 24" PVC flashing.
2. Make all connections through traps. Each trap to be vented, either by circuit, loop, or individual vent, as required, but not less than shown, or as required by local code.
3. Cleanouts shall be installed at the base of all stacks, at all changes of directions greater than 45 degrees and in runs to provide means of cleaning lines at maximum 50' intervals.
4. Coordinate floor drain locations with respect to equipment housekeeping pads. Place drains such that edge of the floor grate extends no further than 2 inches from the side of the pad.

### 3.14 PLUMBING FIXTURES

1. The fixtures shall be furnished complete with chrome plating on exposed piping or trim. Provide anchor bolts, hangers, strainers, faucets and other incidental items furnished as standard. Provide loose key stops at every fixture. All supply fittings and exposed fixture trim shall be all brass, chrome plated.



2. All fixtures are to be new, free of cracks, blemishes or other imperfections and to be "acid-resisting" quality.
3. Set and properly connect all fixtures with hot and cold water, vent and drainage piping, as required and protect fixtures until acceptance and test. Clean all flush valves after two weeks of operation.
4. All piping through walls, floors or ceilings shall have sleeves and escutcheons.
5. Provide all fixture mounting supports and carriers as required to suit field conditions. Carriers and supports shall be floor mounted type except as noted.
6. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Correct any incorrect location of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the engineer. All rough-in to plumbing fixtures shall conform to fixture manufacturer published rough-in dimensions, and requirements.
7. Adjust all plumbing fixtures, faucets and flush valves to meet the maximum water consumption requirements listed herein.

Water closets:	1.6 gallons per flush
Urinals:	1.0 gallons per flush
Lavatory:	0.5 gpm flow restrictor
Showers:	2.5 gpm
8. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
9. Inspect each installed unit for damage to finish. If damaged, restore and match finish to original at site to the satisfaction of the Architect/Engineer; otherwise, remove fixture and replace with new unit. Remove cracked or dented units and replace with new units.
10. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation.
11. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.
12. Exercise care in handling of fixtures, trim, pipe, and fittings. Use tools designed to prevent damage to surface finishes.
13. Set fixtures level and uniformly, with connections at right angles to wall and properly centered. Lay out roughing accurately and in coordination with space and finish requirements. If field cut-outs and holes are required use proper cutting and drilling tools to maintain integrity of finished surface. Provide cut-out templates for countertop insert or undermount items.

14. Locate waste outlets and water supplies at constant horizontal levels, with waste outlet centered on fixture drain connection and water supplies spaced equally to right and left.
15. Support wall hung fixtures rigidly from building construction, not from piping, by means of concealed metal supporting members designed to carry weight of fixture under conditions of unusual loading, with no stress placed on waste connection or any other part of system.
16. Secure floor mount supports to slab. Secure wall mount supports to 1/4 inch thick metal backup plate secured to wall construction. Do not use wire, nails, or other makeshift devices to secure supporting members. Secure recessed and inserted items to supporting surface.
17. Use vandal-proof devices to secure fixtures, trimmings and fittings to deter unauthorized removal. Provide chrome plated brass washers and cap nuts for exposed bolt ends.
18. Provide escutcheons, threaded or held in place with threaded part or set screw, on piping and fixture supports protruding from wall or floor, and on visible connections to fixtures.
19. Make connection between integral trapped fixtures and drainage piping with an approved prepared gasket that shall be a germicide, absolutely gas and fume-proof, watertight, stainproof, containing neither oil or asphaltum, and which will not rot, harden, or dry under any extreme of climatic change, and must adhere on wet surfaces.
20. Use non-ferrous spacing devices to support and stabilize water piping.
21. Paint non-coated ferrous metal surfaces of fixtures, including brackets, hangers, and plates with prime coat of paint.
22. Upon completion of work, remove protective covers and thoroughly clean surfaces, traps and strainers. Check all items for proper operation. Tighten packings and retaining devices.
23. Adjust flush valves to provide minimum flow consistent with cleaning requirements of fixtures. Adjust supplies to provide adequate flow without splashing, and with flow rate of hot and cold water equal in velocity, except as otherwise required.

**3.15 INDIVIDUAL SIZES OF BRANCHES TO FIXTURES**

	COLD	HOT	WASTE	VENT
Water closets(tank)	1/2"	---	4"	2"
Water closets(flush val)	1-1/4"	---	4"	2"
Urinals (flush valve)	1"	---	2"	1-1/2"
Lavatories	1/2"	1/2"	1-1/2"	1-1/2"
Electric water coolers and drinking fountains	1/2"	---	1-1/2"	1-1/2"
Hose bibbs	3/4"	--	---	---

Clothes washer	1/2"	1/2"	2"	1-1/2"
Service sink or mop receptor	3/4"	3/4"	3"	1-1/2"
Sinks	1/2"	1/2"	2"	1-1/2"
Showers	1/2"	1/2"	2"	1-1/2"
Tubs	1/2"	1/2"	1-1/2"	1-1/2"

**3.16 ROUGHING HEIGHTS**

1. Above Finished Floor
  - Lavatories 31" to top of rim
  - Urinals 24" to top of rim
  - Water closets 15" to top of rim
  - Electric water coolers and drinking fountains 33" to top of rim
  - Hose bibbs 24" to bottom of spout
2. Handicap fixtures shall be set in accordance with ADA and local requirements.

**3.17 EQUIPMENT IN OTHER DIVISIONS AND/OR BY OWNER**

1. Kitchen equipment - Equipment will be provided and set by Kitchen Equipment Contractor (K.E.C.), except as noted below or on drawing.
2. Faucets and tailpieces will be provided but not set by K.E.C.
3. Plumber shall provide and install traps and stops and install faucets and tailpieces and connect the service as required.
4. Plumber shall obtain certified prints of roughing drawings of equipment before starting work.

**3.18 GAS SYSTEMS**

1. General: Conform to the requirements of NFPA 54.
2. Provide dirt trap, gas cock, and union at each connection to each piece of equipment.
3. Locate gas piping with adequate separation between electrical cables, equipment, and conduit.
4. Slope gas piping to low points without traps. Provide drips (pipe tee, nipple, and cap) at bottom of all vertical risers and drops.
5. Make branch connections to mains from top or side, not from bottom of main.
6. Extend unthreaded portions of piping at least 2 inches through finished wall surfaces, floors, ceilings and sleeves.

7. Provide and install gas shut-off valves for the proper and safe control of the system.
8. DO NOT locate gas valves in spaces used as air plenums.
9. Verification: before making a gas connection, verify that equipment is compatible with the type and pressure of gas being supplied.
10. Purging: purge gas to safe location.

3.19 PENETRATIONS THROUGH FIRE SEPARATIONS

1. Refer to specifications section 230000.3.14 for firestopping.

3.20 DISINFECTION OF POTABLE WATER SYSTEM

1. Potable water systems shall be disinfected in accordance with State and Local codes but by not less than one of the following methods before it is placed in operation.
2. The system, or part thereof, shall be filled with a solution containing 50 parts per million of available chlorine and allowed to stand 24 hours before flushing and returning to service.
3. The system, or part thereof, shall be filled with a solution containing 200 parts per million of available chlorine and allowed to stand 3 hours before flushing and returning to service.

3.21 TESTS

1. General: Test plumbing systems to satisfaction of Building Official. Do not close in, conceal, or cover up any plumbing work until it has been tested, inspected, and approved.
2. Flush piping, prior to testing, to remove foreign materials which may have entered during course of installation. Clean filters and strainers after flushing.
3. Test all piping except drainage and vent piping, including valves, fittings and joints hydrostatically at a pressure equal to at least 1-1/2 times the normal working pressure of the system under which it is to be used, but no less than 100 psig for a minimum of four hours. Blank off or remove all elements or equipment which may be damaged by the pressure. Open but do not back-seat valves. Inspect all joints and connections.
4. Test rough plumbing drainage and vent system with water or air at least as follows:
  - a. Water test: apply water test to drainage system either in its entirety or in sections. If applied to entire system, tightly close all openings in piping, except highest, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, and fill section with water. In testing successive sections at least upper 10 feet of next preceding section shall be tested, so that no joint or pipe in building (except uppermost 10 feet of system) shall have been submitted to a test of less

than a 10 foot head of water. Keep water in system or in portion under test, for at least 15 minutes before inspection starts; system shall then be tight at all points.

5. Final test for gas and water tightness to be as follows:
  - a. Smoke test: fill all traps with water, and then introduce into the system a pungent thick smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, they shall be closed, and a pressure equivalent to one inch water column shall be held for the test and inspection period.
6. Test all gas piping in accordance with NFPA 54 Section 4 with no leakage noted. Coordinate test procedure and requirements with local utility company.
7. Repair all leaks, defects or damage revealed by the results of the testing and re-test the system.
8. Do not insulate or conceal piping until the system has been tested and the results approved.
9. Perform tests in the presence of the Authority Having Jurisdiction. Notify Architect and/or Engineer.
10. Contractor is responsible for hiring a testing service to test the odorant levels of the above ground gas piping within the building and bear the cost of odorizing the gas piping if the odorant level in the piping system is not 0.10% or above gas in air. Contractor to forward the report to the owner.

### 3.22 TRAINING

1. Provide field training course for Owner's designated personnel. Provide video taping as required.
2. Training shall be provided for a total period of at least (8) hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests.
3. Field training shall cover all of the items contained in the operation and maintenance manuals.

### 3.23 RENOVATION OF AREAS NOT IN PRESENT PHASE OF PROJECT

1. In unrenovated areas, areas not in the present phase of work, that will require any kind of work including but not limited to the installation of new pipe, ductwork, and/or conduit entering, penetrating and/or passing through due to the phasing of the project. This contractor shall be responsible for the covering, moving, relocation, replacing and protecting of the owner's property.

The owner's property shall include but not be limited to furniture, equipment, furnishings, walls, floors and ceilings. This contractor shall be responsible for the cleaning of the room to the level and condition that the room was prior to the commencement of work. A representative of the owner shall review the existing condition of the room prior to work commencing. The cleaning shall include the whipping off, washing of the walls, floors, counter tops, desktops and any and all surfaces that are affected by the installation. After the work has been completed the owner's representative shall provide confirmation that the room has been cleaned to the level that it was prior to the work commencing.

The contractor shall be responsible for the moving, relocation and putting back in place any and all equipment that will be in the area of work.

If this contractor does not clean the room to the level to which it was found, the contractor shall pay any and all costs associated with the room clean up and cleaning.

If this contractor does not put back in place any and all equipment that will be in the area of work, the contractor shall pay any and all costs associated with the room set up.

END OF SECTION

SECTION 23 00 00 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Division shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install all work of this Division as shown on the drawings, as specified herein, and/or as required by job conditions.
2. Refer to specification Division 01. The Commissioning services for Division 23 systems are specified within Division 01 Commissioning. The General Contractor, the division 23 contractor and the GC's Subcontractors shall include all manpower, time, parts, labor, and resources required to accomplish the commissioning as specified.
3. The contractor shall refer to specification 011100 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that they remain active during the construction and renovation of the phased project.
4. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be without the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.
5. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
6. Due to the phasing of this project the contractor shall provide all tie-ins, live or otherwise required to provide functional systems for this project.
7. Existing to remain piping shall be labeled as noted in other sections of these documents, for example Steam piping etc.
8. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.
9. Perform the work in accordance with the above requirements and the provisions of all applicable codes and laws, including but not limited to the current adopted version of the following: IBC, IMC, IPC, IEBC, IECC, ICC/ANSI 117.1, Connecticut State Building Code 2005 Supplement and all other applicable codes.
10. Contractor to have minimum five (5) years of experience and all tradesmen shall have the appropriate licenses.

11. Standard Specifications and Abbreviations:

The following abbreviations used in the Specifications refer to organizations publishing specifications and standards. These shall be construed to mean the latest standard adopted and published at the date of advertisement for bids and such specifications are made part of the Contract Documents to the same extent as if written out in full.

ADA	Americans with Disabilities Act
ADC	Air Diffusion Council
AHDGA	American Hot Dip Galvanizing Association
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	American Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
FIA	Factory Insurance Association
FM	Factory Mutual
FS	Federal Specifications
IGSPHA	International Ground Source Heat Pump Association
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
MCAA	Mechanical Contractors Association of America
MSS	Manufacturers Standardization Society of Valve and Fittings Industry
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety Health Act
PDI	Plumbing and Drainage Institute
PPI	Plastics Pipe Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
UL	Underwriters Laboratories, Inc.
USDC	United States Department of Commerce
USPHS	United States Public Health Service



- a. Conform to ANSI - 31.1.0 and addenda for basic materials and methods of installation for closed piping systems with pressures in excess of 30 PSI, and for pipe welding regardless of system pressures.
- b. Conform to ASME Boiler and Pressure Vessel Code Section VIII and FM requirements for construction of unfired pressure vessels.

1.02 INTENT

1. It is the intention of the specifications and drawings to provide for finished work, tested and ready for operation.
2. Items and services not shown on drawings, but mentioned in specifications, or vice versa, necessary to render the work complete and ready for operation, shall be provided without additional cost to the Owner.
3. Where conflicts occur between drawings and specifications, or within either document, the Contractor shall ask for and obtain a written clarification from the Architect prior to submitting his bid. Otherwise, the items or arrangements of superior quality, greater quantity or higher cost shall prevail and be included in the contract price.
4. The drawings show, among other things, the intent of the system components and routing. Some fittings and accessories are shown, but it is not the intent to show all the fittings and accessories that will be required in order to install the systems in a coordinated way, as finished work. The contractor shall include all fittings and accessories as may be required in order to accomplish the coordination of the various building systems, to ensure the systems fit within the spaces provided.

1.03 WORK INCLUDED

1. The work under this Division shall include all labor, material, equipment plant, services and administrative tasks required to complete and make operable the mechanical work shown on the Drawings and specified herein, including but not limited to, the following:
2. Preparation and submission of shop drawings, diagrams and illustrations.
3. Procuring all necessary permits and approvals, and paying all required fees and charges in connection with the work of this Division.
4. Protection, testing, cleaning, adjustment and guarantee of the work of this Division to safely, properly and continuously operate.
5. As-built drawings, operating and maintenance instructions and manuals.
6. Identification labels, tags, charts and diagrams.
7. Maintain existing services to heating, plumbing, sprinkler systems, etc. (temporary services during construction).
8. Cutting, Excavation, backfill and patching of floors, walls, and ceilings.

1.04 WORK NOT INCLUDED

1. Finish patching of all construction cut under this Division.
2. Waterproofing of roof penetrations for the work of this Division.
3. Concrete and masonry work except as specified.
4. Painting, except as noted.

1.05 SITE INVESTIGATION

1. Examine the drawings and specifications of all trades, and the site, and from these investigations be responsible for the nature and location of work, general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, etc.
2. The contractor shall visit the site and review the extent of removals with in the complex. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The intent of the documents is the removal of existing equipment and infrastructure either noted by the documents or located in the field at no additional cost to the owner. The contractor shall be responsible for the removal of equipment, piping, supports, etc. and infrastructure not being reused. Refer to specification 230500 for additional scope and criteria.
3. The contractor shall refer to specification 011100 for timing and phasing coordination.
4. The contractor shall visit the site and review the extent of relocations with in the complex as it relates to demolition and removals noted in the documents. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The contractor shall be responsible for the relocation of infrastructure as required, either noted by the documents or located in the field, at no additional cost to the owner.
5. The contractor shall refer to specification 230500 for additional scope associated with removals.

1.06 DRAWINGS

1. Drawings are diagrammatic and indicate the general arrangement of systems and work required. Do not scale the Drawings. Consult the architectural drawings and details, and the drawings of other trades, for exact location of equipment.
2. Drawings shall be used in layout of work. Check reference drawings to verify spaces in which the work will be installed. Maintain maximum headroom and space conditions. Where headroom or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
3. If directed by the Architect, make minor modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

4. The drawings are schematic and diagrammatic.
  - a. Symbols and diagrams are used to indicate the various items of work and the complete systems, but not necessarily have dimensional significance; neither do they necessarily delineate all related and subsidiary parts and equipment.
  - b. The work shall be installed complete and ready for operation in conformity with the intent expressed on the drawings and in the specifications.
  - c. Coordinate the work with the requirements of the architectural and structural drawings for dimensions, locations and clearances.
  - d. Locations of items exposed to view shall be taken from the architectural drawings or located as directed.

#### 1.07 COORDINATION WITH OTHER TRADES

1. Closely schedule the work so that work will be installed at the proper time without delaying the completion of the entire project.
2. Where the work will be installed in close proximity to the work of other trades, or where there is evidence that the work will interfere with the work of other trades, arrange space conditions to make a satisfactory adjustment. If work is installed before coordinating with other trades, make necessary changes to the work to correct the condition without additional cost to the owner.
3. Prepare complete set of drawings showing all necessary slab openings and structural supports that require structural framing. Drawings shall clearly indicate sizes and location relative to established column lines. Drawings shall be completed in sufficient time to allow for structural steel fabrication so as not to delay project schedule.
4. Shop drawing submissions shall demonstrate a knowledge of the work of other trades, and shall show the locations of the work of other trades which affects the work of this contract.

#### 1.08 EQUIPMENT DEVIATIONS

1. Where an item of equipment is proposed, other than that detailed or specified on the drawings, which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical or electrical layouts, such redesign, and new drawings required therefore, with approval of the Architect, shall be prepared without cost to the Owner.
2. Where such approved deviation requires a different quantity and arrangement of equipment from that specified or indicated on the drawings, provide required equipment, wiring, piping, connections, valves, and structural supports, and any other additional equipment required by the deviation, at no additional cost to the Owner.
3. It is the intent of these specifications that wherever a manufacturer of a product or a catalog number is specified, and terms "or equal" or "or approved equal" are used, the

substituted item must conform in all essential respects to the specified item including operating efficiency, noise generated, and method of operation. Consideration will not be given claims that the substituted item meets performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.

1.09 EQUIPMENT AND SYSTEMS CRITERIA

1. The criteria of design and performance to produce the required operation are based on equipment shown or scheduled.
2. The equipment must conform to the structural design provisions for loads applied to the structure, to the dimensions established by drawings for machine spaces and other clearances, and for inlet and outlet locations and proper relationship to associated equipment, piping and ducts.
3. The descriptions cover basic equipment and operation but not all the details of design and construction. The use of singular in descriptions does not limit the quantities of items to be furnished to provide the operation specified. Furnish all equipment required to produce specified performance under installed conditions.
4. Factory wiring, interconnections, piping and connections shall conform to these specifications for the field work.
5. Provide all trim, enclosures and accessories required to make a complete installation.
6. Finish mechanical equipment, motors, controls and similar apparatus with machinery enamel, prime coat and finish coat. Provide prime coat suitable for field painting and other protective treatments and coatings as specified.
7. Acoustical performance of equipment and systems.
  - a. Noise levels from operation of motor driven equipment, whether air-borne or structure-borne, and noise levels created by or within air-handling equipment and air distribution and control media shall not exceed sound pressure levels determined by the noise criterion curves in the ASHRAE Guide as follows:

Location	Noise Criterion
Offices	NC 30
Corridors	NC 35
Toilets	NC 35
Classrooms	NC 30
Cafeteria	NC 40
Lobby	NC 35
Media Center	NC 25
Sound Critical Areas:	
TV Studio	NC 20
Control Room	NC 20

- b. Testing for conformance to the above requirements will be provided by an acoustical consultant retained by the Owner.
- c. Octave band sound pressure levels will be obtained for ambient room conditions with equipment not operating and also with the installed equipment operating per plans and specifications.
- d. For testing purposes, sound pressure levels will be measured 3'-0" above the floor.

#### 1.10 APPROVALS

- 1. Obtain all approvals in accordance with Division 1 - General Requirements. Submit to the Architect for approval a list of manufacturers of equipment proposed for the work.
- 2. Intent to use exact make specified does not relieve the Contractor of responsibility for submitting the required list.
- 3. Where any specific materials, process or method of construction, or manufactured article is specified by name or by reference to catalog number of a manufacturer, or other standards, the intent is not to take precedence over the basic duty and performance specified, noted on drawings, or as required for intended results. In all cases, verify the duty specified with the specific characteristics of the equipment offered for approval.
- 4. Equipment of one type shall be products of one manufacturer.

#### 1.11 SUBMITTALS

- 1. Procedure
  - a. Prepare and make the submissions listed below in accordance with the procedure specified in this Section.
- 2. Shop drawings
  - a. Coordination Drawings.
  - b. Guarantees and Warrantees.
  - c. Operating and Maintenance Manual.
  - d. Record As-Built Drawings.
  - e. Identification Markings.
  - f. Fire rated penetration safing.

#### 1.12 SUBMITTALS PROCEDURE

- 1. Refer to Division 1 - General Requirements for number of copies and routing procedure of submittals.
- 2. Shop drawings shall be submitted for each item listed in each specification section of this division or specified on plans.

3. Submittals shall include the following information on a cover sheet:
  - a. Job Name
  - b. Contractor's Name
  - c. Manufacturer's Name
  - d. Specification Section
  - e. Paragraph Number
  - f. Contractor Submission Number
  - g. List drawings and/or sheets included
  - h. List variations from specifications and drawings
  - i. Space for Engineer's and Architect's Review Stamp
  
4. Submittals shall consist of following applicable items:
  - a. Manufacturer's Drawings.
    - 1) Equipment listed in each section, include material specifications, operating characteristics and finishes.
  
  - b. Installation Drawings.
    - 1) Coordinated scale drawings of equipment including interconnecting piping and ductwork.
    - 2) Coordinate space requirements for equipment and services.
    - 3) Include connections, anchorages and fastenings.
    - 4) Make allowance for clearances for access to and maintenance equipment.
  
  - c. Wiring and Control Diagrams.
    - 1) Electric wiring diagrams and automatic control diagrams and sequences of operation. The wiring diagrams must be complete and coordinated with the equipment actually installed.
  
  - d. Provide composite shop drawings showing work of all related construction, when required to ensure full coordination and proper fitting of the work, and when directed by the Architect.
  
  - e. Provide drawings showing dimensions and locations of concrete work required for the mechanical work.
  
  - f. Samples.
    - 1) Color samples for prefinished items.

- g. Reports:
  - 1) Manufacturer's certified pressure tests on vessels.
  - 2) Manufacturer's certified performance tests on operating equipment.
  - 3) Field pipe testing reports and certificates of approval.
  - 4) Welder's certificates and field test report.
  - 5) Field operating test results for operating equipment.
  - 6) Performance report on the balancing of air and water systems.
  - 7) Performance report and calculations for vibration isolation equipment.
  - 8) Manufacturer's certified reports on motorized equipment alignment and installation.
  
- 5. If submissions of catalog cuts of standard manufactured items show different types, options, finishes, performance requirements, or other variations, those features proposed shall be clearly identified.
  - a. If any variations from the catalog description are proposed or required, such variations must be clearly noted on the cut.
  - b. Shop drawings shall clearly indicate all details, sectional views, arrangements, working and erection dimensions, kinds and quality of materials and their finishes, and other information necessary for proper checking and for fabrication and installation of the items, and shall include all information required for making connections to other work.
  - c. Shop drawings shall be numbered consecutively, and drawings related to various units comprising a proposed assembly shall be submitted simultaneously so that units may be checked individually and as an assembly.
  - d. Keep on the site, in good order, a complete up-to-date set of approved shop drawings. All shop drawings shall be available for inspection by the Architect.
  - e. The approval of shop drawings will be general, and shall not be construed as permitting any departure from the contract requirements other than those specifically brought to the Architect's attention and so approved.
    - 1) If the shop drawings show any variations from contract requirements because of standard shop practices or other reasons, such variations shall be clearly identified on the drawings in order that, if acceptable, suitable action may be taken for proper adjustment in other work affected thereby.

- 2) Failure to identify such variations will not relieve the Contractor of responsibility for executing the work in accordance with the Contract even though such shop drawings have been approved and the work installed.
- 3) Approval shall not relieve the Contractor of responsibility for any error in details, dimensions, etc., that may exist on shop drawings nor for the furnishing of materials or work required by the Contract and not indicated on the shop drawings.
- 4) Approval shall not be construed as approved departure from details or instructions previously furnished by the Architect.
- 5) Approval with a requirement for resubmission is an approval contingent upon satisfactory resubmission within 30 days. Failure to comply shall result in a revocation of the contingent approval.

6. Shop Drawing Schedule

- a. The Contractor shall submit, within 30 days of the award of his contract, a schedule of all proposed shop drawing submissions.
- b. The schedule shall include the following information.
  - 1) Item to be submitted
  - 2) Date of submission
  - 3) Latest date for approval
  - 4) Manufacturers of the specified item.
- c. Items not specifically listed as "approved equal" should be listed for consideration at this time.

7. Submittals will be reviewed for conformance with the contract drawings and specifications. The engineer's review stamp will be affixed to submittals. One of the following actions will be taken.

- a. **NO EXCEPTION** - Submittal appears to comply with the contract drawings and specifications. Contractor is not relieved of responsibility to meet the requirements of the contract drawings and specifications due to errors, omissions, or conflicts with other equipment or trades.
- b. **EXCEPTIONS AS NOTED** - Submittal appears to comply with the contract drawings and specifications except for the items noted by the engineer. Contractor is not relieved of responsibility to meet the requirements of the contract drawings and specifications due to errors, omissions, or conflicts with other equipment or trades.
- c. **REVISE AND RESUBMIT** - In the opinion of the engineer the nature and/or quantity of exceptions is sufficient to require resubmission to demonstrate compliance. Submittals must be returned within 30 days for contingent



acceptance to remain valid. Submittals will become rejected if not returned within 30 days.

- d. REJECTED - Submittal does not comply with contract drawings and specifications.

#### 1.13 GUARANTEES AND SERVICES

1. All workmanship, installation materials and equipment shall be maintained and serviced for the guarantee period at no additional cost to the Owner.
2. Leave entire system installed under this Contract in perfect working order, and, without additional charge, replace any work or material which develops defects within the guarantee period, including all other work damaged as a result of such defects.
3. Non-durable, expendable items such as air filter media are not subject to replacement after the date of acceptance.
4. The guarantee period at the completion of each phase shall be extended as follows:
  - a. For heating systems, one year plus the time necessary to include one continuous heating season from November 1st to April 1st.
  - b. For air-conditioning systems, one year plus the time necessary to include one continuous cooling season from May 1st to October 1st.
5. Manufacturers' Warranties
  - a. Warranties for equipment installed in each phase shall be as noted in Paragraphs b. and c. below, except for equipment that serves multiple phases (Boilers, Pumps, Chillers, Cooling Towers, Compression Tanks, Glycol Makeup System, DDC system head end and operator's workstation, etc.) This equipment that serves multiple phases shall be warranted as noted in Paragraphs d. and e. below.
  - b. The manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:
    - 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
    - 2) For a period of 18 months from date of acceptance of each phase of construction by the Owner or twenty four months from date of shipment, the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, labor for parts replacement, and replacement of lost refrigerant, are the responsibility of the installing contractor.

- 3) The manufacturer shall provide an additional warranty on all refrigeration compressors under the same terms as Paragraph 1.13.5.b.2) above, for a period of four years beyond expiration of the 18 month warranty, for a total of 5-1/2 year warranty from date of acceptance by the Owner of the phase of work in which the refrigeration compressor was installed.
  - 4) Tank linings - guarantee all internal metal surfaces against corrosion for ten years from the date of acceptance by the Owner of the phase of work in which the tank was installed.
  - 5) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
- c. The final acceptance by the Owner of the equipment in each phase of construction will be made by the commissioning agent after the manufacturer has adjusted his equipment, balanced the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project.
- d. For Central Plant equipment, and equipment that serves multiple phases, the manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:
- 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
  - 2) For a period of 18 months from date of acceptance by the Owner of the last phase of construction (acceptance of the full building), the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, labor for parts replacement, and replacement of lost refrigerant, are the responsibility of the installing contractor.
  - 3) The manufacturer shall provide an additional warranty on all refrigeration compressors under the same terms as Paragraph 1.13.5.d.2) above, for a period of four years beyond expiration of the 18 month warranty, for a total of 5-1/2 year warranty from date of acceptance by the Owner of the last phase of construction (acceptance of the full building).
  - 4) Tank linings - guarantee all internal metal surfaces against corrosion for ten years from date of acceptance by the Owner of the last phase of construction (acceptance of the full building).

- 5) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
- e. The final acceptance of the equipment will be made by the commissioning agent after the manufacturer has adjusted his equipment, balanced the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project. Particular attention shall be paid to warranty requirements of equipment that serves individual phases and of equipment that serves multiple phases.

#### 1.14 PERMITS AND CERTIFICATES

1. Prior to proceeding with any installation, prepare and submit to the proper authorities, for their approval, all required working drawings. Provide all necessary notices, obtain all permits and pay all local, state and federal taxes, fees and other costs in connection with the work.
2. The contractor shall be responsible for performing all controlled inspections required by applicable Administrative building Code.

#### 1.15 COORDINATION DRAWINGS

1. Sheet metal shop drawings that have been coordinated with architectural and structural drawings shall be submitted to Engineer for approval. Drawings must be returned from Engineer either "No Exception" or "Exceptions as Noted" prior to being used as basis for coordination drawings. Refer to Section 233000 for sheet metal shop drawing requirements.
2. After sheet metal drawings have been revised per Engineers comments, reproducible copies shall be sent to the others trades in the following sequence for the inclusion of their work:
  - a. plumbing contractor
  - b. electrical work
  - c. mechanical piping
  - d. sprinkler piping
  - e. life support subcontractor
3. Prior to inclusion of sprinkler piping and equipment, contractor shall have submitted sprinkler plans and calculations to engineer for approval and to Rating Bureau for review.
4. After all trades have included their work on the coordination drawing and noted conflicts, all trades shall meet to resolve conflicts and agree to acceptable solutions. Each trade shall sign coordination drawings. Items not shown on coordination drawing are responsibility of omitting contractor and contractor is subject to additional costs incurred by other trades.

5. The Architect and Engineer are not part of the coordination drawing process. The Engineer will provide assistance relative to acceptability of installations.
6. Submit final signed coordination drawing to engineer. Only submit items that are different from previously approved shop drawings. Revisions shall be clearly indicated.
7. Any work fabricated or installed prior to sign off by all trades shall be removed and re-installed in conformance with coordination drawings.
8. Each contractor (mentioned above) is responsible for the coordination of his sub-contractors.
9. The overall coordination of the coordination process is the responsibility of the construction manager.

#### 1.16 EXCAVATION AND BACKFILLING

1. Excavation under the lump sum bid shall mean and intend the removal of all materials of every nature and description which are encountered in obtaining the lines and grades indicated or required for the work and which, in the opinion of the Owner, can be loosened and removed by hand, by means of hand tools or by means of power shovels. The Contractor shall assume that all excavations to the lines and grades required can be executed by the aforementioned means.
2. Additional payment will be made by the Owner for the removal of all materials of every nature and description which are encountered in the work to obtain the required lines and grades and which, in the opinion of the Owner, require for removal the use of air operated hammers, barring and wedging or drilling and blasting. Vertical payment lines for such work shall be two feet (2') greater than the external diameter of the pipe installed in the trenches. Payment will be made as follows:
  - a. For the removal of such materials from trench and pit excavation payment will be made at the rate specified elsewhere in these documents.
  - b. No additional payment will be made for the removal of sidewalks, curbs, driveways or pavements regardless of the methods used in removals. Such work shall be included in the work under the lump sum bid.
3. Protection - Provide all necessary and required sheet piling, bracing and shoring to maintain the work safe to life, limb and property and all decking, guard rails and planking for the safety of pedestrians and vehicular traffic and all other precautionary measures as directed.
4. Trimming - The bottom of all excavations shall be trimmed to the lines and grades required for the work.
5. Surface and Subsurface Water - Provide and operate necessary equipment for pumping surface and subsurface water to keep excavations and foundations for the work under this contract dry at all times. The water shall be disposed of into sewers or other carry-off agencies in a manner approved by the Owner.

6. Surface and Subsurface Utilities
  - a. Active Services - When encountered in the work and where indicated on the drawings, all existing active sewer, gas, water, electric and other utility services and structures shall be protected at all times and where required for the proper execution of the work shall be relocated as directed by the Architect. If existing active services are not indicated but are encountered and require protection or relocation the Contractor shall request the Architect in writing for determination and decision in the matter and the work shall not proceed until written directions as to procedure are obtained.
  - b. Inactive Services - When encountered in the work, whether or not indicated on the drawings, all existing inactive sewer, water, gas, electric and other utility services and structures which interfere with the execution of the work shall be removed, capped, plugged or otherwise discontinued.
  - c. The cost of all work connected with protecting and maintaining all utilities shall be borne by the Contractor. The cost of relocating all utilities not indicated to be relocated, but directed to be, shall be borne by the Owner.
7. Blasting - Where blasting is required it shall be done by persons skilled in such work. All blasts shall be properly covered and every precaution shall be taken to insure the safety of person and property. Blasting powder, caps and other explosives shall be stored in accordance with regulations of agencies or bureaus having jurisdiction thereof.
8. Restoration
  - a. Backfilling - After inspection and approval of the work, all sheeting and shoring shall be removed and the excavations shall be refilled with clean earth, thoroughly tamped. Excess material shall be removed as directed. Backfill shall be placed in horizontal layers not exceeding 12" in depth.
  - b. Surface Restoration - Surface of sidewalks, pavements, sodding, shrubs, etc., shall be restored to their original condition except as otherwise specified.
  - c. Removal of Temporary Work - Temporary decking, guard rails, planking and other protective work shall be removed when, in the opinion of the Owner, the need for same ceases to exist.
  - d. Repairs - All work removed or damaged through the installation or removal of the temporary protective work or through improper protection shall be replaced at no additional expense to the Owner.

## PART 2 – DOCUMENTATION

### 2.01 VIDEO RECORDING

1. The contractor shall provide audio video recordings of training and operation for equipment provided to the project.

2. The recording quality shall be such that the audio is clearly distinguishable with zero background noise, and the video should have a studio quality.
3. A professional videographer shall do the recordings. The format shall be in standard Digital Versatile Disk, DVD.
4. The contractor shall provide audio video recordings of equipment maintenance, as described in 230000 2.1 B, C. The recordings shall include the equipment being maintained by qualified personnel, the required maintenance tools, and a step by step technique, both verbally and visually demonstrating how to maintain each piece of equipment in a hands on application.
5. The recordings shall include manufacturer's recommended maintenance items for each piece of equipment provided for the project. The recordings shall also include but not limited to the following: hot water filter changes, cold water filter changes, chilled water filter changes, oil filter changes, air filter changes, the greasing of motor bearings, the greasing of pump housings, the changing of motor belts, Cooling tower draining, cooling tower start-up, seasonal chiller system shut down and start-up, chiller system fluid flushing and replacement, boiler and heat exchanger system fluid flushing and replacement, water treatment, variable frequency drives, starters, contactors replacement heating and cooling coil cleaning, valve actuation and testing, BMS/DDC system's control points and items associated with equipment provided for the project.
6. The finished recordings shall be compiled into chapters. A binder shall be provided for each finished copy of the recordings. The binders shall be provided with a cover sheet, edge sheet, table of contents, disk holders and the description of each disk's recordings.
7. The contractor shall furnish four copies of the finished recordings. Three to be provided to the owner and one copy to the engineer for record.

## 2.02 OPERATING AND MAINTENANCE INSTRUCTIONS

1. Furnish manufacturers operating and maintenance instructions, parts lists and sources of supply for replacements in accordance with Division 1 - General Requirements.
2. Provide the following:
  - a. Complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions, for equipment supplied.
  - b. Bind each set within a common binder. Index and organize with a table of contents, to permit quick and convenient reference.
3. Three days, unless otherwise noted, of instruction in operation and maintenance of each type of equipment to Owner's maintenance force. Provide a training schedule, which is convenient and coordinated with the Owner, during which qualified personnel, including manufacturers' technicians and engineers will be available for Owner's instruction.

4. Master Operating Manual (submit in quadruplicate)
  - a. Manufacturer's mechanical and electrical equipment parts lists of all components of the systems listed on the equipment schedules, control diagrams and wiring diagrams of controllers.
    - 1) List shall give system number, unit number, manufacturer's model number, and manufacturer's drawing numbers.
  - b. Step by step operating instructions for each system including preparation for starting, summer operation, winter operation, shutdown and draining.
  - c. Maintenance instructions for each type of equipment.
  - d. Possible breakdowns and repairs for each type of equipment.
  - e. List of nearest local suppliers for all equipment.
  - f. Manufacturer's literature describing each piece of equipment listed on the equipment schedules, control diagrams and wiring diagrams of controllers and a copy of the air balance report.
  - g. As-installed control diagrams by the control manufacturer.
  - h. Description of sequence operation by the control manufacturer.
  - i. Recommended troubleshooting procedures in the event of foreseeable mechanical system failure.
  - j. Complete "As-Installed" color-coded wiring diagrams of all systems and all electrical motor controller connections and interlock connections of all other mechanical equipment.
  - k. Chart of the tag numbers, location and function of each valve.
  - l. Copies of the following test reports:
    - 1) Air Balance.
    - 2) Water Balance.
    - 3) System Performance.
    - 4) Required Pressure Tests.
    - 5) FM Water Flow Tests.

#### 2.03 RECORD DRAWINGS

1. Provide "Record Drawings" in accordance with Article 4 of the General Conditions Governing all Contracts, indicating in a neat and accurate manner a complete record of all revisions of the original design of the work.
  - a. Include all changes and an accurate record, on reproductions of the contract drawings or appropriate shop drawings, of all deviations, between the work shown and work installed.
2. Submit for approval bound sets of the required drawings, manuals and operating instructions.

3. Submit for approval completed coordination drawings in an AutoCAD 2010 read/write format on Compact disks in a bound and labeled binder.

#### 2.04 IDENTIFICATION MARKINGS

1. General - apply after insulation and field painting are completed.
2. Valve Identification
  - a. Furnish and attach to each valve a 2" diameter tag of solid brass with number and service abbreviated as noted on contract drawings. Numbers to correspond to consecutive numbers on valve chart identifying each individual valve.
  - b. Securely attach tags to the stem of valves with brass "S" hooks.
  - c. Provide valve charts mounted on 1/4" masonite and covered with heat, bonded plastic laminate. They shall identify each valve by a number, service, its functions and list any remarks concerning special features of the valve; its location and the contract drawings which reference the valve.
  - d. Provide one such mounted valve chart in each Mechanical Equipment Room. In addition, furnish one unmounted folded copy of the valve charts for each instruction manual.
3. Piping Identification
  - a. Provide identification for piping exposed, or visible through access panels on bare or covered pipes for all services. Piping shall be identified by prefabricated acrylic plastic markers. Markers shall be snap on or secured with bands (6" and over). Colors and lettering shall conform to ANSI Standard 13.1-1981. Seton Name Plate Company or the approved equal. Generally they shall be located at changes of direction, take-offs, valves, where pipes pass through walls and at intervals not greater than 30'-0" on straight runs.
  - b. Underground piping shall be provided with underground warning tapes, buried above piping run to identify by color and text, the utility below. Non-metallic piping shall be provided with warning tape having metallic core bonded between two polyethylene films. Seton Name Plate Company or the approved equal.
4. Equipment Identification
  - a. Identify all equipment by a permanently attached minimum 1-1/2" x 3-1/2" nameplate of white core laminated bakelite with black surface and incised letters, located where it is legible and accessible. Where possible, mount plates in the same location on all similar pieces of equipment.
  - b. Each unit shall bear a manufacturer's nameplate with the following information:
    - 1) Manufacturer's name and address.
    - 2) Serial and model number.
    - 3) Rated capacity.
    - 4) Temperature pressure or other limitations.



- c. Attach or mount adjacent to all controls and starters, a nameplate indicating which equipment it controls.

### PART 3 - EXECUTION

#### 3.01 COORDINATION AND LAYOUT

1. Study Drawings and Specifications to insure completeness of work required.
  - a. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete work, though not specifically indicated or specified.
2. Verify measurements and conditions in field before starting work.
3. Examine materials to which work is to be applied and notify the Architect, in writing, of any conditions existing which are detrimental to proper and expeditious installation of work.
  - a. Starting of work shall be construed as acceptance of conditions.
4. Confer with other trades, install work to avoid interference with other trades, and possible necessary adjustments to conform to structural conditions and work of other trades.
5. Coordinate and set inserts and locate openings in floors and walls in new construction.
  - a. Locate pipes and ducts to avoid interference with other work shown on the drawings and as directed by the Architect.
  - b. Keep all concealed pipes and ducts within the enclosing construction provided.
  - c. Arrange exposed work neatly in parallel runs and parallel with walls or structure, with uniformly spaced hangers and supports, and within the spaces assigned for each kind of work.
6. Make coordinated layouts showing concrete work required for housekeeping pads, equipment bases and inertia masses which are cast in place, including the location of anchors and dowels.
  - a. Coordinate the scheduling and placing of the concrete to suit the mechanical work schedules.
  - b. Concrete housekeeping pads are to cover the full area of each piece of equipment.
  - c. Concrete bases are to be of dimension and heights to suit the equipment.
  - d. The forming and placing of concrete will be provided under this specification section.

3.02 MAINTENANCE OF EQUIPMENT AND SYSTEM PRIOR TO FINAL ACCEPTANCE

1. Maintain all equipment and systems installed until final acceptance by the commissioning agent, engineer, architect, and owner. Maintenance of the equipment shall be the contractor's responsibility until the final phase of the project has been approved by the Owner as complete. The contractor shall provide general and manufacturer's recommended maintenance. Maintenance shall include but not be limited to: lubrication, Lubricating shafts, belts, hoses, filters (air, oil, fuel), oil changes, cleaning, coil cleaning, valves (automatic, manual), BMS/DDC control system equipment, motorized dampers, Variable action Valves, pump hosing, pump motors, etc., and manufacturer's recommended maintenance items.
2. The contractor shall take such measures as necessary to insure adequate protection of all equipment and materials during delivery, storage, installation and shut-down conditions.
3. This responsibility shall include all provisions required to meet the conditions incidental to the delays pending final test of systems and equipment.
4. After installation of systems has been completed, refer to the phasing document for additional information, operate the system to determine the capability of the equipment and controls to conform to the requirements of the drawings and specifications prior to performance testing.
5. This contractor provides a complete maintenance log for each piece of equipment.

3.03 EQUIPMENT INSTALLATION

1. Locate and set equipment anchor bolts, dowels and aligning devices for all equipment requiring them. Refer to concrete work coordination.
  - a. Level the equipment and grout solid between the equipment and the surface below. Grout to be premixed Embeco or Five Star Grout mixed in accordance with manufacturer's specifications.
2. The field assembly, installation and alignment of equipment are to be done under field supervision provided by the manufacturer or with inspections, adjustments and approval by the manufacturer.
3. Equipment startup.
  - a. Each manufacturer of equipment shall provide qualified personnel to inspect and approve equipment and to supervise the operating tests of the equipment.
4. Equipment and system test operation.
  - a. Notify the Architect in advance of beginning the equipment and system test operation.
  - b. Each piece of equipment shall be operated in its system as long as required to provide proper functioning.

- c. Perform an operating test of each complete system for twenty-four hours continuous operation as a minimum, or as long as required to provide coordination and proper functioning of all related systems and controls.
- d. The operating criteria for each test shall be determined in advance with the Architect's approval whenever seasonal conditions will not produce a full design load on any equipment or system.
- e. Certify to the Owner that all equipment is functioning properly.
- f. Should the apparatus fail to meet the contract requirements, adjust, repair or replace all defective or inoperative parts and again conduct the complete performance tests.

#### 3.04 CLEANING AND ADJUSTING

- 1. Blow out, clean and flush each system of piping, and equipment as required to thoroughly clean the systems.
  - a. Clean all materials and equipment, and leave in condition ready to operate and receive succeeding finishes where required.
  - b. Adjust and align all equipment interconnected with couplings or belts.
    - 1) Adjust valves of all types and operating equipment of all types to provide proper operation.
    - 2) Remove and clean elements in all steam trap bodies.
    - 3) Clean all strainers.
- 2. Lubricate equipment as recommended by the manufacturer, during temporary construction use, and provide complete lubrication just prior to acceptance.
- 3. Permanent equipment operated during construction shall not be abused or be used in service different from its design application.
  - a. Temporary disposable filters shall be used during temporary operation.
  - b. All expendable media, including belts used for temporary operation and similar expendable materials shall be replaced just prior to acceptance.
  - c. Packing boxes of equipment operated during construction must be replaced just prior to system acceptance, using materials and methods specified by the supplying manufacturer.
- 4. Equipment furnished with factory finishes shall be retouched and repainted as required to present a new appearance.

5. Provide and maintain protection for all of the work whether completed or in progress.
  - a. Provide coverings and enclosures as required.
6. New and existing operating equipment and systems shall be clean and dust free inside and out.
  - a. Concealed and unoccupied areas such as plenums, pipe and duct spaces and Equipment Rooms shall be free of rubbish and swept clean at time of acceptance.

### 3.05 TESTING AND BALANCING

1. Tests shall be performed in accordance with Division 1 - General Requirements, and the following.
2. Testing and balancing shall be performed for each phase of the project, for each system and shall be approved by the commissioning agent. Refer to the phasing documents for scheduling and timing.
3. Provide the services of an independent air and water balancing and testing firm that specializes in balancing and testing of heating, ventilating and air conditioning systems, and which is acceptable to the Owner.
  - a. All instruments used shall be accurately calibrated and maintained in good working order. If requested, the balancing shall be conducted in the presence of the Architect/Owner.
4. Balancing shall not begin until the system has been completed and is in full working order. Contractor to refrain from insulating the ducts/piping prior to successful test completion.
5. After completion of the balancing and testing submit copies of the results to the Architect.
6. Perform tests and make necessary adjustments to obtain the flow and distribution of air and water required to produce the operating criteria called for by the contract documents, in accordance with the latest standards of the National Environmental Balancing Bureau and the Associated Air Balance Council.
  - a. Occupied spaces shall be draft free upon completion.
  - b. Provide any necessary baffles at registers and diffusers.
  - c. Maintain the specified acoustical performance of the systems.
  - d. Mark final position of dampers and balancing valves.
7. Upon completion of the installation, test and balance all equipment and systems under field operating conditions to demonstrate its compliance with specification requirements.

- a. Submit three copies of the test report to the Architect. Refer to specification sections 230523 and 233000 for details of report requirements.
8. Should any part of the system fail to meet the contract requirements, adjust, repair or replace all defective or inoperative parts again conduct the complete performance tests.
9. The Architect and Owner shall be notified, in writing, at least 48 hours prior to scheduled test dates.
10. Contractor to refrain from installing sheetrock/walls/blocks before successful completion of all mechanical and plumbing tests.

### 3.06 PAINTING

1. Thoroughly clean all surfaces, requiring prime painting, of rust, loose scale, oil and grease.
  - a. Dry surfaces before painting.
  - b. Do not paint controls, nameplates, or labels.
2. Paint all equipment not painted at the factory with one prime coat.
3. Provide field painting as follows:
  - a. All exposed iron work, including uninsulated ferrous piping and conduit system components, hangers, supports, equipment bases, and apparatus; prime coat, red lead.
  - b. Uninsulated ductwork and casing exposed to view and exposed galvanized surfaces of conduit and piping and of equipment prime painted at the shop: Prime coat, zinc chromate for galvanized surfaces.
  - c. Inside of all ductwork where visible through registers and grilles: One coat of flat black paint.

### 3.07 CONNECTIONS TO EQUIPMENT

1. Provide mechanical connections to equipment and fixtures requiring such connections which are supplied by Owner or under other divisions.
2. Provide unions, nipples, adapters, valves, flexible connections, and other trim required for final connections for each such fixture or item of equipment, as required for complete and perfect operation.

### 3.08 WORKMANSHIP

1. Perform all work in a practical, neat and workmanlike manner with mechanics skilled in work, and using the best practices of the trade involved.

2. No work shall be concealed until it has been inspected and approved by the Architect and the Building Official.
3. Workmanship or materials not meeting with requirements of the specifications and drawings and satisfaction of the Architect shall be rejected and immediately replaced in an acceptable manner, without additional cost to the Owner.

### 3.09 LUBRICATION

1. All equipment furnished, installed or connected under this division, shall be inspected for proper lubrication when connected and before operation of the equipment is begun.
2. The Contractor for the work of this division will be held responsible for any damage to equipment that is operated without having been properly lubricated.

### 3.10 REMOVALS AND RELOCATIONS

1. All components of abandoned systems and abandoned portions of systems shall be removed, and, unless specifically noted to be relocated and reused, become the Owner's property. Contractor shall dispose of removed materials as directed by the Owner.
2. Where portions of systems noted for removal remain in use, permanently seal the point of disconnection so as not to interfere with the system operation.
3. Where interferences between the existing system components and new work require relocation of the existing components to clear that interference, they may be reused, except where specifically noted to the contrary, providing that their condition is noted by the Owner's representative and they are approved by him as equivalent to new.
4. Where existing system components are required to be replaced, all new components shall be provided.
5. System components include all accessories, cables, controls, conduits, hangers, bases and supports and outlets.

### 3.11 USE OF PREMISES AND CLEANING

1. Remove and dispose of all waste materials and rubbish due to all construction operations under the contract, except as otherwise noted, and keep the building free from rubbish and dirt caused by his and/or his subcontractors' employees.
  - a. During the entire progress of the work, rubbish removal shall be made frequently so as to prevent any potential safety or health hazard.
2. Upon completion of the work, remove all protection, paint, putty, and other stains from all fixtures and glass and leave the premises thoroughly broom cleaned.

### 3.12 CUTTING, ALTERING AND PATCHING

1. Provide all cutting, chasing, drilling, altering and rough patching required for the work of this division.

- a. Including the restoring of existing work cut for or damaged by installation of new work, and where present work is removed.
  - b. All materials and workmanship required in connection with cutting, altering and rough patching shall match the existing work in every respect.
2. Do all shoring, bracing, cutting, patching, piecing out, filling in, repairing and refinishing of all present work as made necessary by the alteration and the installation of new work.
3. All holes and openings occurring in the existing floors after equipment, partitions, floors, steel work, conduits and pipes are removed or installed shall be closed up with materials similar to the adjacent work.
4. The size and location of items requiring an opening, chase or other provisions to receive it shall be given by the trade requiring same in ample time to avoid undue cutting of any new work to be installed. These provisions shall not relieve the Contractor from keeping informed as to the required opening, chases, etc., nor from responsibility for the correctness thereof, nor for cutting and repairing after the new work is in place.
5. Include all cutting, repairing and patching in connection with the work that may be required to make the several parts come together properly and fit it to receive or be received by the work of other trades, as shown on the drawings and/or specified, or reasonably implied by the drawings and specifications.
6. All repairing, patching, piecing-out, filling-in, restoring and refinishing shall be neatly done by mechanics skilled in their trade to leave same in condition satisfactory to the Owner.
7. Materials and their methods of application for patching shall comply with applicable requirements of the specifications.
  - a. Materials and workmanship not covered by the specifications and items of work exposed to view adjoining existing work to remain shall conform to similar materials and workmanship existing in or adjacent to the spaces to be altered.
8. Cutting, repairing and patching shall include all items shown on the drawings, specified in the specifications or required by the installation of new work or the removal of existing work.
9. Remove partitions, walls, suspended ceilings, etc., as necessary to perform the required alterations or new construction work.
  - a. Avoid damage to construction and finishes that are to remain.
10. Protect and be responsible for the existing building, facilities and improvements.
  - a. Any disturbance or damage to the work, the existing building, and improvements, or any impairments of facilities resulting from the construction operations, shall be promptly rectified, with the disturbed, damaged, or impaired work, restored, repaired or replaced at no extra cost.

11. All alterations which are not indicated on the drawings nor specified herein but necessary to make good existing work disturbed by reason of the work shall be restored to a condition satisfactory to the Owner.
12. All holes in masonry floors and walls are to be core drilled.
13. Disturbed concrete and/or cement floor areas shall be patched with approved type latex mortar.
  - a. When cement mortar is used for patching, the surfaces shall be depressed a minimum depth of 1".
14. Reinstall all weather protection work in waterproof manner.
15. Openings in roofs.
  - a. Openings in roofs shall be kept properly plugged and caulked at all times, except when being worked on, to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed.
16. Temporary openings.
  - a. All temporary openings cut in walls, floors or ceilings for pipe or ductwork shall be closed off with transite or an equally non-combustible material except when mechanics are actually working at the particular opening.

### 3.13 TEMPORARY HEAT

1. Provide all labor, fuels, materials, tools, appliances and equipment and perform all operations necessary to maintain sufficient temporary heat to insure uninterrupted progress in the work and to protect all work and materials against injury from dampness and cold until issuance of the Certificate of Substantial Completion. In addition to the foregoing, the contractor shall provide temporary heat to the extent itemized below, but not limited to the following:
  - a. During the placing, setting and curing of all concrete, an ambient temperature of 50 degrees F shall be maintained in the areas involved.
  - b. During the placing, setting and/or curing of interior masonry, metal furring, plaster, tile; and taping and spackling of drywall an ambient temperature of 60 degrees F shall be maintained in the space involved.
  - c. In spaces where resilient floor coverings are stored an ambient temperature of 70 degrees F shall be maintained, and such temperature shall be maintained 48 hours before, during and 48 hours after installation in each space where such covering is required.
  - d. Except as noted above, all areas in which work is in progress, shall be maintained at 45 degrees F during working hours.



2. The building will be considered in an enclosed condition when roofing and exterior walls are in place and openings in exterior walls and roof have been provided with temporary or permanent closures.
3. The medium and procedure of providing temporary heat at all times shall be subject to the approval of the Owner and Architect.
4. Prior to the building being in an enclosed condition, temporary heat may be provided by approved type of heating and devices complete with covers, vents and/or smoke connections to the outer air so that all human hazards may be eliminated and the surfaces of the buildings protected against damage by deleterious substances resulting from the heating operations.
5. Only heaters employing tanked gas will be permitted. The use of oil or coke as fuels will not be permitted. Provide thermal protection under heating units and pails of sand adjacent thereto.
6. Prior to starting the metal lathing, or drywall spackling, the work shall be sufficiently advanced for the building to be enclosed and for temporary heat to be produced by the permanent heating system.
7. After the building is enclosed and the permanent heating system or portion of the system is substantially complete and acceptable to the Owner for temporary heating use, the contractor may, at the Owner's discretion, be permitted to use such heating facilities for temporary heat.
8. The contractor in using the permanent heating system for temporary heating agrees to the following:
  - a. After the Architect and the Owner approve and accept the project heating system, or portion thereof, for temporary heating purposes, the heating system shall be turned over to the contractor. When the contractor has no further need for temporary heat, the heating system shall be returned to the Owner.
  - b. The contractor shall assume the cost of the fuel, the cost of other operating supplies used for temporary heating and the costs involved in the operation and maintenance of the temporary wiring and electricity. If the adaption of the temporary heating system to the contractor's temporary heating needs makes necessary the installation of temporary control valves, gauges, or piping, or the installation of temporary radiation units, the contractor shall bear the costs of such adaptations.
  - c. That portion of the project's heating system and other related mechanical equipment termed the temporary heating system shall be limited to equipment and the necessary piping, traps, valves, strainers, controls, pumps, starters, wiring and all other apparatus and equipment necessary to cause the temporary heating system to function correctly.
9. The cost of maintenance of the temporary heating system for temporary heating is the responsibility of the contractor.

10. Permanent ductwork and air handling systems may not be utilized for temporary heat. The permanent boilers and piping systems may not be utilized for temporary heating without the operation of the permanent water treatment system.
11. These provisions for temporary heating do not alter the requirements of the "General and Supplementary General Conditions" with respect to "Guarantees" and/or any "General Guaranty" contained herein.

#### 3.14 PENETRATIONS THROUGH FIRE SEPARATIONS

1. Pack annular space between sleeve and pipe (insulation) and/or conduit in fire rated construction with fire retardant putty, sealant and/or caulk. Material shall be non asbestos based and installed in accordance with manufacturers instructions for fire rating required.
2. Penetrations of multiple items and penetrations with annular space greater than 1/2" shall be provided with approved backing material in accordance with manufacturer's instructions.
3. Fire retardant sealer and system shall meet ASTM E-84, ASTM E-814, and UL-1479.
4. 

MANUFACTURER	MODEL
Dow Corning	Firestop 2001
Nelson	CLK, FSP
Standard Oil	Fyre Putty
3M	CP-25

#### 3.15 SHUTDOWN OF EXISTING BUILDING SYSTEMS

1. Do not interrupt existing services or systems in the building unless absolutely necessary. Such interruptions and interferences must be made as brief as possible and only after coordination with the Owner. The Owner requires a minimum of seven (7) days notice. Obtain prior permission, in writing.
2. Where the work makes temporary interruptions unavoidable, they shall be made during off hours.
3. Arrange to work continuously, including overtime, if required, to assure that systems will shut down only during the time actually required to make the necessary connections to existing work.

#### 3.16 SEISMIC RESTRAINT INTERNATIONAL BUILDING CODE 2003

1. Provide seismic restraint of all mechanical, electrical, plumbing and fire protection systems as required per IBC Code 2003 Sections 1621 and referenced sections and publications.
2. Seismic restraint calculations shall be provided for all connections of components to the structure. Calculations must be stamped by a registered professional engineer with at least five years experience in seismic design experience, licensed in the State of Connecticut.

3. Analysis must indicate calculated dead loads, seismic static loads, capacity of materials utilized for connection to equipment and structure. Analysis shall detail anchoring methods, bolt diameter, embedment and/ or welded length. All seismic restraint devices shall be designed to accept without failure, the lateral forces acting through the center of gravity.

### 3.17 SEISMIC BRACING

1. Prepare and make the submissions listed in accordance with the procedure specified in this Section. Contractor shall provide complete sealed seismic calculations performed by an engineer currently licensed by the State of Connecticut. This shall include all seismic calculations for piping, ductwork and equipment required to be seismically braced to comply with seismic requirements of the applicable Codes.

### 3.18 RENOVATION OF AREAS NOT IN PRESENT PHASE OF PROJECT

1. In unrenovated areas (areas not in the present phase of work) that will require any kind of work, including but not limited to the installation of new pipe, ductwork, and/or conduit entering, penetrating and/or passing through due to the phasing of the project, this contractor shall be responsible for the covering, moving, relocation, replacing and protecting of the Owner's property. The Owner's property shall include but not be limited to furniture, equipment, furnishings, walls, floors and ceilings. This contractor shall be responsible for the cleaning of the room to the level and condition that the room was prior to the commencement of work. A representative of the Owner shall review the existing condition of the room prior to work commencing. The cleaning shall include the wiping of and/or washing of walls, floors, counter tops, desktops and any and all surfaces that are affected by the installation. After the work has been completed, the Owner's representative shall provide confirmation that the room has been cleaned to the level that it was prior to the work commencing. This contractor shall be responsible for the moving, relocation and putting back in place any and all equipment that will be in the area of work. If this contractor does not clean the room to the level to which it was found, the contractor shall pay any and all costs associated with the room clean-up. If this contractor does not put back in place any and all equipment that will be in the area of work, the contractor shall pay any and all costs associated with the room set-up.

END OF SECTION

SECTION 23 05 00 - DEMOLITION AND REMOVALS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall comply with the General Requirements of Division 1.
2. The contractor shall refer to specification 011100 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that, they remain active during the construction and renovation of the phased project.
3. The contractor shall visit the site and review the extent of removals within the complex. The contractor shall also refer to the architectural documents for the additional locations of demolition and removal. The intent of the documents is the removal of existing equipment and infrastructure either noted by the documents or located in the field at no additional cost to the owner. The contractor shall be responsible for the removal of equipment, piping, supports, etc. and infrastructure not being reused. The contractor shall refer to the architectural documents for the additional locations of demolition and removal.
4. The contractor shall visit the site and review the extent of relocations within the complex as it relates to demolition and removals noted in the documents. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The contractor shall be responsible for the relocation of infrastructure as required, either noted by the documents or located in the field, at no additional cost to the owner.
5. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be without the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.

1.02 WORK INCLUDED

1. The Work of this Section includes all labor, materials, equipment and services necessary to complete the demolition as shown on the drawings and specified herein, including, but not limited to, the following:
  - a. Removal and capping of existing mechanical and electrical systems as appropriate to condition.
  - b. Disposal of material, equipment, and items removed during demolition work.
  - c. Protection of persons, trees, property, adjacent structures, utilities and other materials to remain.

- d. Obtain all necessary permits from authorities.

### 1.03 CONDUCT OF WORK

1. The existing facility will be in operation during the performance of the Work.
  - a. When necessary to temporarily disconnect any existing feeder or branch circuit, domestic water, and chilled/hot water and steam service supplying occupied facilities, confer with the Owner and schedule a mutually agreeable period of interruption.
  - b. Where replacement, relocation or modification of existing equipment is indicated, provide and maintain all temporary feeders, connections, and any other materials and appurtenances required to maintain services to occupied areas.
2. No work shall be left incomplete, nor any hazardous situation created, which will affect the life or safety of the public and/or building occupants. At no time shall the work interfere with or cut off any of the existing services without the Owner's prior written permission.
3. The Owner reserves the right to operate all existing electrical and mechanical equipment not included in this work, and to perform all required servicing and repairs to same, at all times.
4. It is required that the work indicated and/or specified shall be carried out with a minimum of interference to the established operations of the Building.

### 1.04 PROJECT SITE CONDITIONS

1. Site Visit: Examine the site and existing buildings in order to determine the existing conditions, character of equipment and facilities needed for the performance of demolition work.
  - a. Investigate adjoining construction and underlying conditions including field verification of electrical and mechanical system locations.
  - b. Investigate the conditions of public thoroughfares and roads as to availability, clearances, load limits, and other restrictions or limitations affecting transportation to and from site.
2. Building Conditions: Accept the condition of the site and building structures as found. The Architect and Owner assume no responsibility for condition of site nor structures nor the continuation of the condition existing at time of bidding.

### 1.05 GENERAL

1. Products and materials furnished for the work of this section shall comply with other Sections of Division 23.

1.06 PREPARATION

1. Contractor's Verifications
  - a. Check existing conditions of Project, including adjacent elements subject to damage or to movement during demolition, cutting, and removal operations.
2. Utility Disconnections: Disconnect and cap existing utility, electrical, and other service lines.
  - a. Do not interrupt existing utility service or adjacent occupied or used facilities except when authorized. Provide temporary services during accidental or unavoidable interruptions to existing utilities.
  - b. Remove, seal, cap, disconnect and make safe utilities serving the structure to be demolished. Remove wires and cap conduits of electrical systems and any steam or water services. Disconnects or capping shall be to the point of service origin or otherwise clear of new work for the Project. Verify terminations prior to start of demolition work.

1.07 DEMOLITION

1. Codes: All demolition work shall be completed in compliance with all governing codes, standards and regulations. The use of explosives in demolition operations is prohibited.
2. Dust, Dirt and Noise Control:
  - a. Use water sprinkling, temporary enclosures, and other suitable methods as necessary to limit the amount of dust and dirt rising and scattering in the air to the lowest level of air pollution and to prevent dust from being a nuisance to the public or causing damage.
  - b. Maintain noise abatement program to keep noise level at lowest possible level. Work shall be carried out during daylight hours on weekdays only in accordance with regulations.

1.08 CUTTING

1. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surface to receive installation of work by others and patching of finish surfaces.

1.09 REMOVAL, CLEAN-UP AND DISPOSAL

1. General: Remove from the site all debris, rubbish and other materials resulting from demolition operations as work progresses. Storage or sale of demolished materials will not be permitted on the Project site.

2. Removal:
  - a. Transport all materials removed from demolished building structure and dispose of all from the Project site. Do not accumulate debris on site during progress of work.
  - b. Remove debris and litter of man-made materials, equipment or machinery which is not otherwise scheduled to be salvaged for Owner.
3. Disposal and Transport:
  - a. Disposal shall be at legal off-site disposal areas.
  - b. Transport materials over legal haul routes and obtain necessary permits for transporting and disposal as required by local regulations.

#### 1.10 EXISTING MECHANICAL WORK AND REMOVALS

1. Remove, reroute or relocate any piping, ductwork, controls and other mechanical items which are rendered inactive in the course of, or interfere with, the alterations. Remove all newly and previously exposed and or inactive piping, ductwork, etc. which interfere with the alterations.
2. It is the intention of these specifications to provide for the continuance of all mechanical services presently installed in areas not being altered under this scope of work. Provide all interconnecting piping, ducts, controls and equipment necessary to maintain services to these areas.
3. Compare the plans with the existing conditions to determine the amount of work affected. Remove all unused mechanical equipment, piping, ductwork, controls and the like not required by the alterations.
4. All equipment, piping, and materials required to be removed and not reinstalled under this Division of the Work, unless otherwise indicated, shall become the property of the Contractor and shall be removed from the site and properly disposed of.
5. Where piping and branch lines are indicated to be removed, they shall be completely removed back to their source. Accessible piping shall be removed completely; piping embedded in concrete or masonry shall be cut off flush and the surface patched with concrete smooth and level.
6. Where ductwork and branch lines are indicated to be removed, they shall be completely removed back to their source. Exposed or accessible ductwork shall be removed completely; ductwork passing through concrete or masonry shall be removed in its entirety and the surface patched with concrete smooth and level.

7. Where control wiring and tubing and branch lines are indicated to be removed, they shall be completely removed back to their source. Exposed or accessible control tubing and wiring shall be removed completely; tubing passing through concrete or masonry shall be removed in its entirety and the surface patched with concrete smooth and level.
8. No removed existing piping or materials shall be reused.
9. All lengths of control tubing no longer required due to system modification shall be removed completely. No tubing shall be abandoned in place, unless embedded in concrete or otherwise specifically noted.
10. Remove all existing air handlers and fans located on each floor and the roof unless otherwise noted on the drawings. Remove all existing ductwork associated with each air handler and fan on each floor or roof unless otherwise noted.
11. Boiler B-1 and related accessories shall be removed to allow for installation of hot water boiler plant. Boiler B-2 and related accessories shall remain in operation throughout the course of the project, until all spaces requiring steam heat have been converted to be heated by the hot water boiler plant. At that point, Boiler B-2 and all steam and condensate piping and equipment in the Boiler Room shall be removed. Hot water boiler plant shall be operable to serve renovated and/or new spaces in each phase of the work. After boiler B-1's removal, retain any spare parts from that boiler that may be utilized in the existing boiler to remain, B-2.
12. Remove all existing steam radiation, convectors, unit ventilators and associated piping serving all floors unless otherwise noted.
13. Remove all existing exhaust fans, ventilators, and exhaust ductwork located on floors and on roof unless otherwise noted.

#### 1.11 EXISTING PLUMBING WORK AND REMOVALS

1. Remove, abandon, reroute or relocate any piping and other plumbing items which are rendered inactive in the course of, or interfere with, the alterations. Remove all newly and previously exposed piping and plumbing equipment which interfere with the alterations.
2. It is the intention of these specifications to provide for the continuance of all plumbing services presently installed in areas not being altered under this scope of work. Provide all interconnecting piping and devices necessary to maintain services to these areas.
3. Compare the plans with the existing conditions to determine the amount of work affected. Remove all unused plumbing equipment, fixtures, piping and the like not required by the alterations.
4. All equipment, fixtures, piping, and materials required to be removed and not reinstalled under this Division of the Work, unless otherwise indicated, shall become the property of the Contractor and shall be removed from the site and properly disposed of.



5. All connections to piping to be removed shall be properly plugged or capped.
6. Where piping and branch lines are indicated to be removed, they shall be completely removed back to their source. Accessible piping shall be removed completely; piping embedded in concrete or masonry shall be cut off flush and the surface patched with concrete smooth and level.
7. No dead ends shall be left on any piping upon completion of work.
8. All lengths of piping no longer required due to system modification shall be removed completely. No piping shall be abandoned in place, unless embedded in concrete or otherwise specifically noted.
9. All systems shall be left in perfect working order upon completion of all new work.
10. No removed existing piping or materials shall be reused.
11. All existing piping that will be reused shall be inspected and tested for adequate size and condition of pipe. Existing sanitary and storm piping being reused shall be reamed clear full bore and flushed prior to reuse.

#### 1.12 EXISTING FIRE PROTECTION WORK AND REMOVALS

1. Existing fire department connection shall remain for temporary use until new connection is installed. Existing fire department connection shall be connected temporarily to new system piping. Refer to the phasing documents for coordination and timing.
2. Existing 6" underground water supply shall remain and be reconfigured to clear new mechanical tower addition.
3. All existing sprinkler heads, mains, and branch piping shall be removed from the Lower Level and Ground Floor in their entirety.
4. Existing 4" riser piping in northwest stair shall be removed in its entirety.
5. Existing 4" riser piping in southwest stair to remain. Existing floor control valves shall be removed and replaced with new as indicated on the new work drawings.
6. Existing 4" riser piping in southeast stair to remain. Existing floor control valves shall be removed and replaced with new as indicated on the new work drawings.
7. Existing 4" riser piping in northeast stair to remain. Existing floor control valves shall be removed and replaced with new as indicated on the new work drawings.
8. Existing side-wall sprinkler heads at existing passenger elevator shall remain and be reconnected to new system piping.
9. Existing 2-1/2" standpipe riser at column lines K/2 and associated control valves shall remain.

10. Remove, reroute or relocate any existing piping, valves, and other items which are rendered inactive in the course of, or interfere with, the alterations.
11. Compare the plans with the existing conditions to determine the amount of work affected. Remove all unused mechanical equipment, piping, ductwork, controls and the like not required by the alterations.
12. All equipment, piping, and materials required to be removed and not reinstalled under this Division of the Work, unless otherwise indicated, shall become the property of the Contractor and shall be removed from the site and properly disposed of.
13. Where piping and branch lines are indicated to be removed, they shall be completely removed back to their source. Accessible piping shall be removed completely; piping embedded in concrete or masonry shall be cut off flush and the surface patched with concrete smooth and level.
14. No removed existing piping or materials shall be reused.

1.13 HAZARDOUS MATERIAL REMEDIATION

1. Refer to description of work under separate cover and Section 00 30 00 and the supplemental information included in that section.

END OF SECTION

SECTION 23 05 13 - MOTORS AND STARTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the Contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.
2. The installation and equipment is to conform to applicable building code articles and applicable reference standards cited therein.

1.03 SUBMITTALS

1. Procedure
2. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
3. Shop Drawings
  - a. Submit motors with individual items of driven equipment.
  - b. Starters - Technical specs and application data.
  - c. Schedule of starters including starter model, equipment served, starter enclosure, and accessories.
  - d. Submit starter and drive unit wiring diagrams with the automatic control shop drawing submission required under Section 230000.
  - e. Variable speed drive units - Technical specs and application data.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000.

1.05 GENERAL REQUIREMENTS

1. Provide all necessary contacts, relays and switches for motor operation in accordance with the control system sequences and safety device operation.
2. All motors, starters, push buttons, signal devices and motor controller equipment shall be NEMA standard and UL listed.
3. All motors shall be covered by the warranty provided by the original equipment manufacturer which shall extend for a period of 18 months from the point of substantial compliance of a given phase from the commissioning agent, for the full extent of the project. No motor shall be installed which has been manufactured more than two years prior to delivery.

PART 2 - PRODUCTS

2.01 MOTORS

1. All motors shall be general purpose squirrel-cage induction type, NEMA Design B, Class B insulation, continuous duty, 40 °C ambient, single or multiple speed as scheduled.
2. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method B in accordance with following tables:

<b>Open Drip Proof (ODP)</b>			
Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%		77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%
40	94.1%	94.1%	92.4%
50	94.1%	94.5%	93.0%
60 -75	94.5%	95.0%	93.6%
100	95.0%	95.4%	93.6%
125	95.0%	95.4%	94.1%
150	95.4%	95.8%	94.1%

<b>Totally Enclosed Fan-Cooled (TEFC)</b>			
Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%		77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%
40	94.1%	94.1%	92.4%
50	94.1%	94.5%	93.0%
60	94.5%	95.0%	93.6%
75	94.5%	95.4%	94.1%
100	95.0%	95.4%	93.6%
125	95.0%	95.4%	95.0%
150	95.4%	95.8%	95.0%
200	95.8%	96.2%	95.4%

3. Unless otherwise indicated, motors 1/2 horsepower and larger shall be three-phase; motors less than 1/2 horsepower shall be single phase. Motor voltage shall be as indicated; verify with Division 16.
4. All motors shall have a 1.15 minimum service factor.
5. Two speed motors shall be two winding type, RPM as noted on plans.
6. Single speed motors shall operate at 1750 RPM unless otherwise indicated.
7. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31). Motors to have Class F insulation rated at 105° C rise.
8. All motors shall have a terminal box, appropriate mounting base, and a ground post for connection of a ground conductor.
9. Motor enclosures shall be open drip-proof unless otherwise indicated or required.
10. Motor manufacturers:
  - a. General Electric Co.
  - b. Baldor
  - c. Westinghouse
  - d. Marathon

2.02 MANUAL STARTERS

1. Provide manual starters for single-phase motors that are not interlocked with other equipment.
2. Starter shall include quick make-quick break toggle mechanism in a suitable enclosure. The overload relay shall be field adjustable to +/-10% of nominal rating.
3. 

Manufacturer	Series
Cutler Hammer	9101
Square D	Class 2510 Type F
Westinghouse	MS

2.03 MAGNETIC STARTERS

1. Provide electrically-held magnetic starter for three-phase motors 1/2 horsepower and larger. Magnetic starters shall be combination type, with adjustable motor circuit protector, across-the-line contactor, and thermal overload relay in a common enclosure.
2. The motor circuit protector shall trip instantaneously when the motor current level is in excess of the trip setting. Trip settings of all poles shall be adjusted simultaneously by a single trip point adjustment.
3. The starter shall be suitable for connection to a power system having available fault current of 100,000 RMS symmetrical amperes.
4. Furnish contactors with one N.O. auxiliary interlock contact for the holding circuit, and a minimum of two additional auxiliary contacts. Coordinate auxiliary contacts with Section 230943.
- E. 

Manufacturer	Series
Cutler Hammer	
Square D	Class 8539
Westinghouse	Class A206

2.04 STARTER ACCESSORIES

1. Enclosure shall be NEMA 1 for dry location, NEMA 4 for wet or outdoor locations.
2. The disconnect handle shall be capable of being padlocked in the open position.
3. Provide all starters unless otherwise specified with manual reset thermal type overload relays having inverse time delay characteristics and interchangeable heater elements.
4. Provide each starter with a red running light, neon type, mounted through cover.

5. Provide each starter with a three position, maintained contact, H-O-A selector switch, mounted through the cover.
6. Provide two speed starters for all motors listed with multiple speeds in the equipment schedules. Multiple speed starters shall be provided with a time delay relay when switching to a lower speed.
7. Furnish contactors with one N.O. auxiliary interlock contact for the holding circuit, and a minimum of two additional auxiliary contacts for each motor speed. Coordinate auxiliary contacts with Section 230943.
8. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage. Provide adjustable response delay.

## 2.05 VARIABLE FREQUENCY DRIVES

1. General
  - a. Where variable speed control is indicated in drawings, schedules, or specifications, provide complete factory-assembled and -tested adjustable frequency AC drives as herein specified.
  - b. Variable frequency drives (VFD's) shall provide stepless speed control of standard NEMA Design B squirrel cage induction motors, without motor derating.
  - c. VFD's shall be variable torque design, suitable for HVAC pump, fan, and blower applications.
  - d. VFD's shall be tested and listed to the following standards:
    - 1) UL Standard 508C
    - 2) IEEE Standard 519-1992
    - 3) NEMA – ICS 7.0, AC Adjustable Speed Drives
    - 4) IEC 16800 Parts 1 and 2.
  - e. Each VFD shall be appropriately sized and rated to suit the driven load and input power characteristics.
  - f. VFD logic and control circuitry shall be microprocessor-based.
2. Design and Construction Features
  - a. Where located indoors in non-damp and non-wet environment, VFD enclosures shall be steel, ventilated NEMA 1, with hinged lockable door, suitable for wall mounting in sizes through 75 HP (at 460 VAC). Larger units shall have floor

mounted, freestanding enclosures. Where located outdoors, or where VFD is mounted in damp or wet environment, provide NEMA 3R enclosures with strip heater.

- b. The input section shall include a full-wave diode bridge rectifier, padlockable door-interlocked disconnect switch, input power fuses, input line reactor, and output reactor / filter for circuits longer than 75 feet.
- c. The inverter section shall be sine-coded pulse-width-modulated (PWM), utilizing Insulated Gate Bipolar Transistors (IGBT's).

3. Performance Features

- a. Produce rated output under the following service conditions:
  - 1) Rated input voltage +/- 10%.
  - 2) Ambient temperature 0°C. to 40°C.
  - 3) Relative humidity 0-95% non-condensing.
  - 4) Elevation up to 3300 feet above sea level.
  - 5) Input frequency 60 hertz, +/- 2 hertz.
- b. Input displacement power factor - minimum 0.95 at any speed.
- c. Output - 6 to 60 hertz, 0 to input volts, with adjustable volts/hertz.
- d. Overload capability (without trip) - 115% rated output for 10 minutes.
- e. Adjustable output current limit - to 115%.
- f. Adjustable acceleration and deceleration rates.
- g. Adjustable minimum and maximum speed limits.
- h. Automatic restart after an input power loss, with adjustable time delay, if RUN command is still activated.
- i. Input current THD - 5% maximum.
- j. Efficiency - minimum 96% at full load, full speed.
- k. Capable of a smooth start into a rotating motor (either direction).
- l. Minimum 2 second power loss ride-through for logic and control power.
- m. Motor noise attributable to the VFD shall be less than 3 dB above that with across-the-line operation, measured at 3 feet from the motor centerline.



- n. Capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
  - o. Ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
  - p. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in NEC Table 430.250 for 3-phase alternating-current motors.
  - q. The VFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.
  - r. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430.
  - s. Include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
  - t. Capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false under-load condition.
  - u. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
  - v. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
4. Protective Features
- a. Integral  $I^2t$  electronic motor overload protection, adjustable.

- b. Integral trip circuits for input power undervoltage, overvoltage, phase loss, and overcurrent.
  - c. Integral trip circuits for internal overtemperature, DC bus overvoltage, and internal or output circuit ground fault.
  - d. The VFD's shall be suitable for connection to a power system having available fault current of 100,000 RMS symmetrical amperes.
  - e. The VFD's shall be self-protecting against an open output circuit.
  - f. Provide input power line surge protection.
  - g. Provide user-selectable manual or automatic restart after a fault.
5. Controls and Indications
- a. LED or LCD digital information display, including:
    - 1) Output frequency, voltage, and current.
    - 2) Input voltage, current, and KW.
    - 3) % speed.
    - 4) % load.
  - b. LED lamp or alphanumeric display indication of individual fault conditions.
  - c. Status indicators for POWER ON, READY, and RUN.
  - d. 3-position, maintained contact, Hand-Off-Auto selector switch.
  - e. Remote-Local speed reference selector.
  - f. Integral keypad for manual (local) speed control, adjustment, and programming functions.
  - g. Interfaces for remote safety contacts, start-stop contacts, and speed control (4-20 mA, 0-5 VDC, or 0-10 VDC, user selectable).
  - h. Form C (SPDT) dry contacts, wired to terminal blocks, for remote indication of RUN or FAULT.
  - i. Minimum of 3 programmable resonant frequency lockout bands.
6. Serial Communications
- a. The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet

shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.

- b. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
- 1) Data Sharing – Read Property – B.
  - 2) Data Sharing – Write Property – B.
  - 3) Device Management – Dynamic Device Binding (Who-Is; I-AM).
  - 4) Device Management – Dynamic Object Binding (Who-Has; I-Have).
  - 5) Device Management – Communication Control – B.

If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.

- c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
- d. The VFD shall allow the DDC to control the drive’s digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive’s digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive’s digital and analog inputs shall be capable of being monitored by the DDC system.

- e. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.
7. EMI / RFI Filtering
- a. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
8. Special Features
- a. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.
  - b. Door interlocked, pad-lockable, circuit breaker that will disconnect all input power from the drive and all internally mounted options.
  - c. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted.
  - d. The drive / bypass shall provide single-phase motor protection in both the VFD and bypass modes.
  - e. The following operators shall be provided:
    - 1) Bypass Hand-Off-Auto
    - 2) Drive mode selector
    - 3) Bypass mode selector
    - 4) Bypass fault reset
  - f. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.
    - 1) Power-on (Ready)
    - 2) Run enable (safeties) open
    - 3) Drive mode select damper opening
    - 4) Bypass mode selected
    - 5) Drive running
    - 6) Bypass running
    - 7) Drive fault

- 8) Bypass fault
  - 9) Bypass H-O-A mode
  - 10) Automatic transfer to bypass selected
  - 11) Safety open
  - 12) Damper opening
  - 13) Damper end-switch made
- g. The following relay (form C) outputs from the bypass shall be provided:
- 1) System started
  - 2) System running
  - 3) Bypass override enabled
  - 4) Drive fault
  - 5) Bypass fault (motor overload or underload (broken belt))
  - 6) Bypass H-O-A position
- h. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.
- i. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman’s Override 2). The remote start/stop contact shall operate in VFD and bypass modes.
- j. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman’s override. Two modes of operation are required.
- 1) One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
  - 2) The second fireman’s override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).
- k. The VFD shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
- l. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

- m. There shall be an internal switch to select manual or automatic bypass.
  - n. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.
  - o. Output Reactor - A reactor (dv/dt filter) is to be installed between the drive and the motor if the total electric feeder distance between the two exceeds 75 feet.
9. Factory Testing and Warranty
- a. Each unit shall be fully tested prior to shipment, including operation at full load for 8 hours in a 40°C ambient.
  - b. Each unit shall be fully warranted by the manufacturer for a period of 18 months from date of acceptance, including the cost of all parts, labor, and travel expenses.
10. Acceptable Manufacturers
- a. Subject to compliance with requirements, provide variable frequency drives manufactured by one of the following:
    - 1) Allen-Bradley
    - 2) Yaskawa E7 Series
    - 3) Asea Brown Boveri (ABB)
    - 4) Graham / Danfoss
    - 5) Square D
    - 6) Benshaw

### PART 3 - EXECUTION

#### 3.01 GENERAL

- 1. Motors shall be supplied as part of factory assembled equipment specified in other sections.
- 2. All starters and variable speed drives shall be turned over to the Division 16 contractor for mounting, installation, and wiring in conformance with all applicable codes and ordinances. Starters and drives shall be located within line-of-site of the associated equipment being controlled.
- 3. Install overload heaters, adjust overload relays, and set motor circuit protectors in accordance with motor nameplate ratings and NEC Article 430.
- 4. Unless noted otherwise, starters for outdoor equipment shall be mounted attached to or adjacent to the equipment served and shall be provided with NEMA 3R enclosures with strip heaters.

3.02 MOTOR NOISE LEVEL

1. Motor drives for pumps and refrigeration machines, or other mechanical equipment having a motor installed within a mechanical room, shall operate with noise levels not exceeding 85 dBA.
2. Noise levels shall be determined in accordance with IEEE Standard #85 "Test Procedure for Air-Borne Noise Measurements on Rotating Electric Equipment".
3. Motor drives for fans, regardless of where located, or other mechanical equipment located outside mechanical equipment spaces, shall not contribute to increase the manufacturer's sound power ratings by 2 dB in any octave band.

3.03 VARIABLE FREQUENCY DRIVE START-UP

1. A factory authorized field service technician shall perform inspection of the drive installation and wiring, initial energizing and start-up, and the adjustments and programming necessary to achieve specified operation and performance.
2. The factory-authorized field service technician shall program the 3 available resonant frequency lockout bands during motor/drive start-up based on actual motor/equipment performance for each drive. Provide the necessary frequency and vibration testing instruments.
3. After successful start-up, a factory authorized representative shall provide two (2) training sessions at four (4) hours each to Owner's personnel.
4. VFD vendor shall conduct on site harmonic measurements before and after start up of VFD's. If the site measurements show that harmonic contribution has exceeded IEEE-519 then VFD manufacturer shall provide recommendations on additional filtering components to attain IEEE-519 levels.

3.04 MAINTENANCE

1. The contractor shall maintain the equipment listed in this section during the warranty period. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner.
2. The contractor shall maintain the equipment in this section until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.
3. The maintenance shall include but not be limited to monthly greasing, equipment checks, phasing test for the addition of new equipment and piping, and cleaning.

END OF SECTION

SECTION 23 05 23 - PIPING, VALVES AND FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of section 230000, General Provisions, and with the provisions of all applicable codes and laws.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop drawings
  - a. Piping Materials, Joints and Fittings.
  - b. Piping Specialties.
  - c. Valve Tags and Name Plates with Schedule and Location.
  - d. Valves.
  - e. Strainers.
  - f. Expansion tanks
  - g. Hot water accessories
  - h. Anchors and guides
  - i. Safety valves
  - j. Plate Frame Heat Exchanger
  - k. Hot water radiant panels
  - l. Thermometers, gauges, complete listing with scale range and normal operating point.
  - m. Water balance, contractors qualification, procedures, and report format
  - n. Water Balance Report.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000. Produce and maintain required effect under operating criteria determined in advance by agreement with the Architect.



**PART 2 – PRODUCTS**

**2.01 PIPING MATERIALS**

1. All pipe shall be new, free from scale or rust, and of the material and weight specified under the various services. Each length of pipe shall be properly marked at the mill for proper identification with name of symbol or manufacturer.
2. All steel piping shall be standard or extra strong weight, in conformance with the ASTM designation A-106 as manufactured by National Tube Division, Republic Steel Corp., or approved equal. Piping shall be seamless except as specified herein.
3. All brass piping shall be standard or extra heavy weight 85% red brass semi-annealed seamless-drawn, in conformance with the ASTM designation B-43, as manufactured by Anaconda, American Brass Co., Chase Brass and Copper Co., or Revere Copper and Brass, Inc.
4. All copper tubing shall be of weight as required for service specified in conformance with ASTM designation B-88-47 for types "L" and "K" tubing, as manufactured by Chase, Anaconda, Revere, or approved equal. Copper tubing shall be used as specified in the schedule. Tubing and fittings shall be thoroughly cleaned with sand cloth and treated with an approved flux before solder is applied.
5. All galvanized steel piping shall be standard or extra strong weight, as specified, in conformance with the ASTM designation A-106. Pipe shall be hot-dipped zinc-coated with prime western spelter and not wipes.
6. Generally, unless otherwise specified, joints in steel and wrought-iron piping of sizes 2 inches and under shall be screwed, and all sizes 2-1/2" inches and over shall be welded or flanged. All drain piping shall be screwed. Brass pipe shall be screwed 2 inches and smaller and flanged 2-1/2 inches and over. Copper tubing shall be silver-soldered or 95-5 solder as herein specified.

**2.02 FITTINGS**

1. Fittings shall be as specified under "Fitting Schedule" for various services.
2. Welding fittings shall be of the same material and schedule as the pipe to which they are welded. Welding elbows shall be long radius pattern unless clearances necessitate the use of standard radius pattern. Welding fittings shall be Tubeturn or Ladish.

Steel Welding Fittings	ASTM A-106
Wrought Iron Welding Fittings	ASTM A- 72
Malleable Iron Fittings	ASTM A-197
Cast-Iron Fittings	ASTM A-126
Brass Fittings	ASTM B- 62
Solder Fittings	ASTM B- 88

3. All fittings used at expansion loops or bends shall be extra heavy.
4. Cast-iron, malleable-iron and bronze fittings shall be of Crane Manufacture or approved equal.

5. Flanges shall be of the same weight as the fittings in each service category. All flanges shall be drilled and spot faced in conformance with fittings. Screwed and loose flanges shall be of cast iron. Welding flanges shall be of steel welding neck type, flanges on brass to be Crane No. 2104 or approved equal.
6. Flanges shall be faced and true and made up perfectly square and tight with gaskets. Bolts, nuts and gaskets shall be dipped in a mixture of graphite and oil just before installation.
7. Unions - Unions 2 inches and smaller shall be screwed. Unions 2-1/2" and larger shall be flanged. Screwed unions on steel pipe, unless otherwise specified, shall be of malleable iron with bronze ground seats suitable for 300 pounds, W.S.P. Screwed unions on brass pipe shall be brass, ground joint suitable for 300 pounds W.SP. Flanged unions shall be malleable iron, gasket type suitable for 150 pounds W.S.P. Unions shall be as manufactured by Crane, Dart or approved equal.
8. Brass pipe threads shall be cut with special brass threading dies, and the joints shall be made with lubricant. Strap wrenches, or equivalent, shall be used in making up brass pipe. Wrenches that gouge or scar the pipe will not be used.
9. Solder for each solder-type fitting shall be of 95% tin and 5% antimony or silver solder, as specified herein.
10. Fittings shall be of the eccentric reducing type unless otherwise noted, where changes of size occur in horizontal piping to provide for proper drainage or venting. Steel pipe bends shall be made of the very best grade open hearth, low carbon steel, leaving a smooth uniform exterior and interior finish. Pipe bends shall be made with seamless steel pipe, leaving a minimum radius of not less than five (5) pipe diameters.

2.03 PIPE SCHEDULE

1. All piping materials installed under this Section shall be new and shall consist of the following materials and construction:

Service	2" and Smaller	2-1/2" and Larger
Condenser Water Supply and Return	<p>Construction: Threaded construction with threaded or flanged connections to equipment as required.</p> <p>Piping: Black Steel, Schedule 80, Seamless, ASTM A106, Grade A or B.</p> <p>Fittings: Cast iron ASTM A126B, Class 250, threaded ends.</p>	<p>Butt welded construction with flanged connections to valves and equipment as required.</p> <p>Black steel, schedule 40, seamless, ASTM A106, Grade A or B.</p> <p>Steel, Class 300, butt welded, ASTM A234, WPA</p>

Service	2" and Smaller	2-1/2" and Larger
Chilled Water Glycol Hot Water Hot Water Vents and Drains	<p>Construction: Solder joint construction with threaded adapters as required. 95-5 Tin/Antimony solder.</p> <p>Piping: Copper, Type L, hard drawn, ANSI H23.1, ASTM B88.</p> <p>Unions: Bronze solder ends, ground joints, ANSI B16.19 or ANSI B16.22.</p> <p>Flanges: Cast bronze, Class 150, solder type, ANSI B16.24</p>	<p>Welded construction with flanged connections to valves and equipment</p> <p>Black steel, schedule 40, seamless, ASTM A106, Grade A or B.</p> <p>Steel, Class 150, weld type, ANSI B16.5, ASTM A181, Grade 1.</p> <p>Steel, Class 150, weld type, ANSI B16.5, ASTM A234, Grade WPA</p>
Cooling Coil Drains Cold Water Make-Up	<p>Construction: Solder joint construction with threaded adapters as required. 95-5 Tin/Antimony solder.</p> <p>Piping: Copper, Type L, hard drawn, ANSI H23.1, ASTM B88.</p> <p>Fittings: Cast bronze or wrought copper, solder ends, ANSI B16.189 or ANSI B16.22</p>	<p>Solder joint construction with threaded adapters as required. 95-5 Tin/Antimony solder.</p> <p>Copper, Type L, hard drawn, ANSI H23.1, ASTM B88.</p> <p>Cast bronze or wrought copper with solder ends, ANSI B16.19 or ANSI B16.22.</p>
Refrigerant:	Copper Type "K"	Wrought silver brazed tempered tubing.
Fuel Oil:	Copper Type "K"	Wrought silver brazed tempered tubing.

2. Flange Bolts and Nuts:

Bolts: ANSI B181, ASTM A307, Grade B, square head, course-thread series, Class 2B fit.

Nuts: ANSI B18.2.2, ASTM A307, Grade B, hexagonal, heavy series, semi-finished, course-thread series, Class 2B fit.

3. Gaskets: Flat ring 1/16-inch thick, compressed synthetic fiber with SBR binder. Garlock Style 3200, or an approved equal.
4. Welded Joints: Branch lines and changes in direction shall be made with factory weld fittings such as tees, 90 ells, 45 ells, weld-o-lets, thread-o-lets, and welding saddles. Job fabrication of fittings and stab-ins is not permitted.

#### 2.04 JOINTS

1. Brass pipe threads shall be cut with special brass threading dies, and the joints shall be made up with lubricant. Strap wrenches or equivalent, shall be used in making up brass pipe. Wrenches that gouge or scar the pipe shall not be used.
2. Flange joints shall be faced true, packed and made up perfectly square and tight. Each flange joint shall be provided with best grades steel bolts and with hexagon nuts. Flanges shall be raised face, suitable for pressure of system in which they are installed.

#### 2.05 PIPE HANGERS AND SUPPORTS

1. Provide necessary structural members, hangers and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc., are supported from concrete construction, do not weaken concrete or penetrate waterproofing. All hangers and supports shall be capable of screw adjustment after piping is erected. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted both in the vertical and horizontal direction, as required. Hangers in contact with copper or brass pipe shall be copper plated steel or provided with felt sleeve.
2. Pipe hangers shall be of the band type for piping 2" and smaller, clevis for pipe 2 1/2" and larger except where otherwise noted. Hangers for generator exhaust and steam pipe 2" and smaller shall be of the clevis roller type and two rod roller type for pipe 2 1/2" and larger except where otherwise noted.
3. All vertical piping shall be supported by means of heavy wrought iron or steel clamps securely bolted or welded to the piping, and with end extension bearing on the building. Riser clamps shall be constructed of two flat wrought steel bar yokes formed to fit the pipe and bolted together.
4. Beam clamps - hangers supported from steel shall be center loading beam clamps for hangers supporting piping 2 inches. For piping 2-1/2 inches and larger, I beam clamps shall be forged steel. "C" clamps are not to be used.

5. Where piping is run near the floor and not hung from the ceiling construction, but is supported from the floor or in a trench, such supports shall be of pipe stanchion with base flange and adjustable top yoke with u-bolt retainer.
6. Where piping is run above the floor, and is not hung from the ceiling construction or not supported from the floor, such piping shall be supported from the wall with bracket hangers, expansion bolted or fish plated to the wall. Provide details for review by structural engineer.
7. For water piping (fluid less than 100F), provide insulated saddle with vapor barrier or pipe insulation plus protection shield with vapor barrier jacket. For steam, condensate, and hot-water heating piping 2 inches and smaller same as above. For hot-water heating piping 2-1/2 inches and larger, provide steel pipe covering protection saddles spot welded to pipe with insulation insert.
8. Piping in trenches shall rest or hang from angle iron cross supports provided by this Contractor.
9. Hanger rods shall be of galvanized steel not exceeding six (6) feet in length of the following diameters. Trim excess rod to within 1" of the support. Supplementary steel shall be provided as necessary

PIPE SIZE	ROD DIAMETER
2 inches and below	3/8 in.
2-1/2 & 3 in.	1/2 in.
4 & 5 in.	5/8 in.
6 in.	3/4 in.
8 in. and above	7/8 in.

10. Support Schedule

All hanger components of hanger assembly shall be hot dip galvanized or cadmium plated.

TYPE	GRINNELL	NATIONAL	SUPER TOLCO	CARPENTER & PATTERSON	M-CO
Band	70	110/115	2	1A	105
Clevis	260	215	1	100	401
Clevis roller	181	250	324	140	610
Two rod roller hanger	171/177	255/260	322	109	605

Riser Clamp	261	420	6	126	510
Stanchion w/U-bolt	259	X	102	125	721
Wall Bracket	199	710	30H	139	353
Insulation Shield	167	307	220	265	125
Insulation Saddle	160-165	310-340	260-265	351-357	X
Beam Clamp	133/228	680/695	62	82/287	360/361
Insert	281/282	600	309/310	108/650	355
Insert	X	555/560 561	107F/109F 109	104M/104F 143	320
Guide	255/256	120	420/421	S794	650 651
Insulated Shield	X	Pro-Shield	X	265CVB 465CVB	123 124

2.06 ANCHORS AND GUIDES

1. Anchor chair shall be fabricated of steel and welded to steel pipe for a minimum of 12" along top or bottom steel pipe centerline. Non ferrous pipe anchor chair shall be clamped to pipe at each end of chair (chair to be minimum of 12" long). Anchor chair shall be welded or bolted to steel restraining supports which are bolted to building structural steel.
2. Anchor chair shall be equal to Elcen Figure #278 for 4" and smaller pipe, and Figure #281 for pipe larger than 4".
3. Guides shall be fabricated of a split housing joined by a minimum of four bolts, and a split spider assembly of four arms joined by four bolts. Housing shall be at least three times the anticipated pipe movement. All guides for systems operating over 210 °F shall be a minimum of 12" long. Guide shall be welded or bolted to steel restraining supports which are bolted to building structural steel.
4. Guides shall be equal to Elcen Figure #411A, 411B, 412A, and 412B, of the approved equal of Metaflex.
5. Provide anchors and guides as indicated on plans or as required to properly restrain motion of piping without inducing undue pipe stress.

2.07 VALVES - GENERAL

1. All valves shall be of a design which the manufacturer lists for the service and shall be of materials allowed by the latest edition of the ASME Code for Pressure Piping for the pressure and temperature contemplated, unless a higher grade or quality is herein specified. All valves shall be of the same manufacturer, except for special applications.

2. The system shall be supplied with gate or butterfly type isolation valves as specified herein, at all branches mains and risers. Ball valves may be used in lieu of gate valves for pipe sizes 2" and under.
3. All valves shall be installed with the best workmanship and are to have neat appearance and be arranged so that they are easily accessible.
4. Each valve shall have the maker's name or brand, the figure or list number and the guaranteed working pressure cast on the body and cast or stamped on the bonnet, or shall be provided with other means of easy identification.
5. Check valves installed in the horizontal position shall be swing checks; valves installed in the vertical position shall be silent checks, except that all check valves in pump discharges shall be silent checks.
6. Provide blow-off valves at all strainers, and where shown on the drawings.
7. Provide valve operating chain on all gate and globe valves in Mechanical Equipment Rooms - 3" and larger, which are more than 6'-6" above the operating floor. Unit shall be complete with adjustable sprocket, chain and guide (Crane "Babbit" type). Provide hook to keep chain out of the way.
8. Generally, all valves are to be of the gate type, except that globe valves shall be used for throttling services and on traps, and pressure reducing and control valve by-passes. Globe valves used on by-passes shall have monel metal mountings.
9. All valves 2 inches in diameter and smaller shall be all bronze with bronze bodies. Valves 2-1/2 inches in diameter and larger shall have iron bodies with bronze mountings unless otherwise specified.
10. All flanged-end valves shall have renewable metal seat rings and discs. On gate valves these parts shall be of bronze, on all globe valves they shall be of bronze and suitable for throttling service.
11. All screwed-end globe valves shall be of the union bonnet type, non-rising stem with renewable metal seats and discs.
12. All valves shall have their bonnets back-seated to provide for packing under pressure.
13. All gate valves shall be of the solid tapered wedge type, union bonnet, rising stem.
14. All valves 5 inches in diameter and larger shall be furnished with an integral by-pass and a by-pass suitable for the operating pressure.
15. Drain valves shall be provided on tanks, receivers, risers and where they may be required or necessary, or directed for draining the lines and equipment. Drain valves or plug cocks shall be provided at the low points for proper drainage, and where required or directed cocks and valves shall be provided with threaded ends for hose connections.

16. All valves up to 2 inches in diameter shall have screw ends, 2-1/2" in diameter and over shall have flanged ends.
17. Isolation valves shall be provided at all pumps, tanks, reducing and automatic or mechanical flow control devices, radiation, coils and heat exchangers, and at all other apparatus requiring partial drainage of the system for periodic maintenance or inspection. The isolation valves shall be so located as to permit removal and/or service of the isolated equipment without draining complete or substantial portions of the system.

Provide flanges or union(s) to permit removal of all equipment isolated as indicated above.

The flow and control diagrams do not indicate the complete requirement for isolation valves in the system. Manual valves are depicted in flow diagrams to show relative positions of division 230923 control devices.

**2.08 VALVE SCHEDULE**

1. All valves shall conform to the requirements of this Section for the services indicated and shall be provided as indicated on the Drawings.
2. Valves for glycol hot water, hot water, chilled water, condenser water, cold water (make-up), and pumped condensate piping systems shall comply with the following:

Valve Type	Manufacturer	Construction
Gate Valves 2" & smaller Class 150	Stockham B-124 Milwaukee 1169 NIBCO S-134	Bronze body, solid wedge disc, rising stem, union bonnet, threaded ends, 150 psi SWP, 300 psi WOG.
Gate Valves 2-1/2" & larger Class 125	Crane 465-1/2 Stockham G-623 Milwaukee F-2885 NIBCO F-617-0	Iron body, solid wedge disc, OS&Y, bolted bonnet, flanged ends, 125 psi SWP, 200 psi WOG.
Globe Valves 2" & smaller Class 150	Crane 7TF Stockham B-22T Milwaukee 590T NIBCO T-235-Y	Bronze body, composition steam disc, union bonnet, threaded ends, 150 psi SWP, 300 psi WOG.
Plug Valves 2-1/2" & larger Class 125	DeZurik 118F Milliken 601/600 Homestead 120	Cast iron body, eccentric acting, resilient plug facing, stainless steel bearings, nickel seat flanged ends, ANSI 125, 150 psi CWP
Swing Check Valves 2" & smaller Class 150	Crane T/S-433 Stockham B-309/319 Milwaukee 07 NIBCO 563Y	Bronze body, horizontal swing, bronze re-grinding disc, Y-pattern, threaded ends, 150 psi SWP, 300 psi WOG.



Swing Check Valves 2-1/2" & larger Class 125	Crane 373 Stockham F-931 Milwaukee F-2974 NIBCO F-918	Iron body, horizontal swing, bolted cap, flanged ends, 125 psi SWP, 200 psi WOG.
Spring Check Valves 2" & smaller Class 150	Mueller 109M-BP Watts Series 600 Apollo 61-500	Bronze body, globe type, stainless steel spring, bronze seat and disc, flanged ends.
Spring Check Valves 2-1/2" & larger Class 125	Mueller 105M-AP Watts ICVF-125 NIBCO F-910	Iron body, globe type, stainless steel spring, bronze seat and disc, flanged ends.
Ball Valves 2" & smaller Class 150	Watts B-6001 Apollo 70-200 Crane 9322 Stockham S-216 BRRS Milwaukee ML-123E NIBCO LD2000	Bronze body, two-piece, full port, reinforced Teflon seats, lever operated. 150 psi SWP 600 psi WOG. Stem extensions with sleeves shall be provided to suit insulation thickness, so handle is located clear of insulation.
Butterfly Valves 2-1/2" & larger Class 125	Crane 44-FXZ Stockham LD-712 Milwaukee ML-123E NIBCO LD2000	Ductile iron body, lug type, stainless steel stem aluminum-bronze disc, bronze or Nylatrin GS bushings, EPDM liner, with lever lock handle for 6 inches and smaller and weatherproof gear operators for 8 inches and larger, and memory stop on return piping valves.
Triple Duty Valves Class 125	Bell & Gossett 3DS Mueller 721 Taco MPV	Combination balancing, shut off and check valve. Cast iron body, bronze seat and disc, rising stem, 175 psi WOG, ANSI Class 125

3. Combination Balancing/Flow Measuring Valve

- a. Valves 1/2-inch to 3-inch size shall be of bronze/brass ball construction with glass and carbon filled TFE seat rings. Valves shall have differential pressure read-out ports across valve seat area. Read-out ports shall be fitted with internal EPT inserts and check valves. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves shall have memory stop feature allowing valve to be closed for service and then opened to setpoint without disturbing balance position. All valves to have calibrated nameplates to assure specific valve settings. Valves shall be designed for positive shut-off.
- b. Valves shall be manufactured by Bell & Gossett, Armstrong or Griswold.

2.09 PRESSURE RELIEF AND REDUCING VALVES (WATER)

- 1. Relief - bronze, approved adjustable type with test lever and drain extended to spill over floor drain. Approved by ASME and so stamped.

- |    |   |   |
|----|---|---|
| a. | Manufacturer<br>Watts<br>Apollo<br>Bell & Gossett | Type/Series<br>Series 174A<br>10-600 Series<br>790/1170 |
|----|---|---|
2. Reducing - in fill and makeup line. All bronze adjustable diaphragm type with built-in strainer.
- |    |   |  |
|----|---|--|
| a. | Manufacturer<br>Watts<br>Apollo<br>Bell & Gossett | Type/Series<br>N Series<br>36 Series<br>B Series |
|----|---|--|
3. Furnish lock-shield valve by-pass connection for quick filling of system.

2.10 AUTOMATIC AIR VENTS

1. Furnish where shown on drawings and wherever else required, for water systems, of float type to expel air from system and prevent air binding. Provide each valve with 1/2" shut-off valve and overflow of soft copper tubing extended to spill over nearest open drain.
- |    |  |  |
|----|--|--|
| 2. | Manufacturer<br>Sarco<br>Armstrong<br>Bell & Gossett | Type/Series<br>Type 13W<br>AR<br>97/98 |
|----|--|--|

2.11 STRAINERS

1. There shall be approved strainers in the inlet connections to each valve feeder and makeup connection, each water regulating valve, and each diaphragm valve, and where else indicated on the drawings. The intention is to protect by strainers, all apparatus of an automatic character, whose proper functioning would be interfered with by dirt on the seat, or by scoring of the seat.
2. All strainers shall have cast iron, semi-steel or bronze bodies of ample strength for the pressure to which they shall be subjected, removable cylindrical or conical screens of monel or stainless steel and suitable flanges or tappings to connect with the piping they serve. They shall be of such a design as to allow blowing out of accumulated dirt, and to facilitate removal and replacement of a strainer screen, without disconnections of the main piping.
3. All strainers shall be Y-type with removable screen. Two-inch and smaller or where installed in non-ferrous piping system, screwed or flanged, bronze Sarco type BT.
- |    |   |
|----|---|
| a. | 2-1/2" and larger in ferrous piping systems, flanged cast iron Sarco type AF-125.<br>Brass screens for water 1/16" for 3" inclusive; 1/8" for 4" and above. |
|----|---|

2.12 EXPANSION TANKS - DIAPHRAGM TYPE

1. Welded steel shell of size and volume indicated on equipment schedules. Tanks shall be constructed in accordance with ASME Section VIII, and shall bear the ASME stamp.
2. Diaphragm of heavy duty butyl, rated to 240<sup>0</sup>F and 125 PSIG working pressure.
3. Accessories:
  - 1-1/2" NPT system connection.
  - 1-1/2" charging valve.
  - Lifting rings, welded to shell
  - Welded base or saddles (horizontal units).
4. 

Manufacturer	Type/Series
Amtrol, Ex-Trol	AX, L
Bell & Gossett	B, D
Armstrong	

2.13 WATER SYSTEM ACCESSORIES

1. Provide the following accessories in the water circulating systems.
  - a. Airtrol tank fitting.
  - b. Tank drain.
  - c. Make-up water pressure reducing valve.
  - d. Pressure relief valve.
  - e. Backflow preventer
  - f. Air vents - at all high points - Automatic in mechanical spaces, manual in concealed spaces.
  - g. Pipe line air separators.

2.14 DRIP PAN ELBOW

1. Cast iron body with inlet matched to outlet of relief valve.
2. Unit to include discharge slip arrangement to relief riser and dual drain connections. Oversized relief riser to be supported independent of relief valve and drip pan elbow.
3. Manufacturer:
  - Crane-Cochrane
  - Farris
  - Lonegran

2.15 PLATE TYPE HEAT EXCHANGERS

1. General

- a. Provide plate and frame heat exchangers with capacities shown on the drawing schedules. Heat exchangers shall be single pass, counter-current flow design, with all end connections on the stationary cover plate. Plate heat exchangers shall be designed, constructed, and tested in accordance with Section VIII, Division I of the ASME Pressure Vessel Code, and shall be code stamped.
- b. Heat Transfer Fluids: Low Temperature Heating Hot Water
- c. Frame shall be designed to permit future installation of a minimum of 50% additional plates.
- d. Maximum velocity at the fluid connections shall not exceed 10 FPS.
- e. Minimum fluid velocity between plates shall be 0.5 FPS.
- f. The maximum allowable overall fluid pressure drop shall be 5 psi.
- g. Unit shall have independent certification through AHRI per Standard 400. Manufacturer and Model shall be listed on the AHRI website.”

2. Frame Components

- a. The fixed and movable covers shall be of sufficient thickness for the design pressure and code requirements and shall have no welded reinforcements or stiffeners.
- b. The carrying and guide bars shall be designed to allow for expansion of at least 50%.
- c. The portion of the carrying bar and guide bar system which comes in contact with the plates shall be stainless steel to prohibit corrosion and facilitate movement of the plates. Painted or plated surfaces are not permitted.
- d. Entire frame shall be bolted together to allow unit to be field assembled to permit rigging into place. Welding of the frame components is not permitted.
- e. Plate and carrying bar design shall permit the removal or access to any plate in the plate pack without the need to remove any other plates.
- f. Provide lifting lugs for units with 6 inch ports or larger designed to allow lifting of the entire unit's flooded weight.
- g. All steel surfaces shall be thoroughly cleaned and prepared for painting per SSPC-SP1063T, painting over mill scale is not acceptable. All carbon steel components shall be Aliphatic Acrylic Polyurethane coated.

3. Connections
  - a. Connections equal to or less than 2" shall be stainless steel NPT type.
  - b. To avoid leakage on port area, studded port design shall be provided on heat exchangers with connections greater than 2". Flanged nozzle connections are not acceptable.
  
4. Compression Bolts
  - a. Compression bolts shall not require special tools and shall be equipped with lock washers at the movable cover to facilitate opening and closing of the unit from the fixed cover.
  - b. Compression bolts shall be equipped with captive nuts at the fixed cover and threaded nuts at the movable cover. Welding of the nut to the closure bolt is prohibited.
  - c. Bolts shall be provided with rolled threads to reduce galling and double width hex nuts to adequately distribute the load.
  - d. Compression bolt material shall be carbon steel. Bolts shall be liberally coated with Gleitmo 500 for lubrication and rust prevention, and covered with a plastic protective sleeving for protection from the environment and to prevent bodily injury. Zinc plating is prohibited.
  - e.
  - f. The bolting system shall be designed so that only four (4) compression bolts are required for the opening and closing of the unit.
  
5. Plates
  - a. The plate and frame heat exchanger shall consist of pressed type AISI 304 to provide the required heat transfer area to meet the operating conditions specified. Minimum thickness shall be 0.5 mm.
  - b. Individual plates shall be pressed from a homogeneous single metal sheet in one step. No multi-stage pressing of one sheet is allowed.
  - c. Each heat transfer plate to be with herringbone corrugations to optimize heat transfer with nominal pressure losses. Corrugations to be designed to provide support to adjacent plates at evenly distributed support points to allow pressurization of each circuit to a full design pressure with no pressure on the adjacent plate channels without buckling or deformation of the heat transfer plates. (Full pressure differential)
  - d. All plates and gaskets shall be permanently marked to identify quality and material.

- e. Each heat transfer plate shall have a built-in self-aligning system to accurately locate the plates in the frame assembly and prevent lateral plate movement and maintain maximum gasket contact under pressure.
  - f. Plates shall be reinforced on the upper and lower mounting slots to avoid bending hangers on the plates.
  - g. The plate and frame heat exchanger shall be designed to perform the capacities and pressure drops as shown on the schedule. Plates to be have a II B surface finish and tapered gasket grooves.
  - h. The plate pack shall be covered with a aluminum shroud in accordance with OSHA.
6. Gaskets
- a. Gaskets shall have relieving grooves to prevent intermixing of fluids and cause leak to flow to outside of unit.
  - b. One piece molded clip-on High Temp. NBR gaskets are required and shall fit around both the heat transfer area and the port holes.
  - c. Preference shall be given to non-glued gasketing systems.
  - d. If an adhesive is necessary, it shall be compatible with the gasket material and the fluids. The adhesive shall be a 2 component epoxy glue and heat cured.
7. Inspection, Testing & Shipment
- a. The plate heat exchanger shall be tested to full test pressure of 1.3 times the design pressure of 150 psi in one circuit with zero pressure in the alternate circuit.
  - b. Hydrostatic test shall be in accordance with ASME Section VIII, Division 1, paragraph UG-99.
  - c. The plate heat exchanger shall be ASME U stamped.
  - d. A nameplate shall be securely attached to the exchanger in a location that is easily accessible and visible after installation. The nameplate must include working pressure, design temperature, closing dimension, surface area, media, and plate/gasket material.
  - e. The plate heat exchanger shall be flushed clean at factory prior to shipment. All connections shall be factory sealed to prevent the entrance of foreign material during transit.
  - f. Port locations shall be clearly marked on the heat exchanger and shall correspond to vendor drawings.

8. Insulation:
- a. Factory furnished, removable insulation cover with minimum .040" aluminum jacket. Insulation shall be nominal 2" polyisocyanurate foam board panels yielding a minimum R-value of 14.4.
  - b. Factory furnished 24 gauge carbon steel drip tray with drain.
  - c. Insulation shall be formed with latches to completely surround the entire plate frame assembly and drip tray
  - d. Install Insulation assembly per manufacturer's guidelines and recommendations.
9. Manufacturer:
- Alfa-Laval
  - Tranter
  - Bell & Gossett

2.16 PRESSURE GAUGES

- 1. Phosphorous bronze Bourdon tube type, cast aluminum 4-1/2" diameter case with blowout disc, stainless steel movement with bronze bushing brass socket and black numerals on a white face.
- 2. Accuracy: 1/2 or 1% of scale range.
- 3. Scale to be selected so that normal operating point is between 35% and 65% of full scale.
- 4. Each gauge to include brass petcock. Gauges on steam piping to include syphon.
- 5. Gauges to be installed:
  - a. Across water coils.
  - b. Across tube bundles (e.g. chiller evaporator, chiller condenser, convertors).
  - c. Suction and discharge of pumps.
  - d. Inlet and outlet of pressure reducing valves.
  - e. Inlet and outlet of steam control valves.
  - f. Additional locations as shown on plans.
- 6. 

Manufacturer	Series
H.O. Trerice	500X
U.S.Gauge	
Albert A. Weiss	UG-1
Weksler Instruments	AA1

2.17 THERMOMETER

1. Mercury filled red reading column type, 9" long, with one piece aluminum case and sealed replaceable glass element. Brass stem with union connection and adjustable angle to permit reading from any angle. Black numerals on white background.
2. Accuracy: 1% of scale range.
3. Scale to be selected so that normal operating point is between 35% and 65% of full scale.
4. Each thermometer to be installed in an extension neck brass separable socket. Extension neck length to be coordinated with insulation thickness. Socket and thermometer insertion length to be minimum of 75% pipe diameter.
5. Thermometers to be installed:
  - a. Supply and return of water coils (single return on multiple coil bank)
  - b. Supply and return of tube bundles (e.g. chiller evaporator, chiller condenser, convertors)
  - c. Circulating pump discharge.
  - d. Supply and return of water boilers.
  - e. Additional locations as shown on plans.
6. 

Manufacturer	Series
Taylor	E
H.O. Trerice	BX
Weksler Instrument	AA5

2.18 REMOTE READING THERMOMETER

1. Mercury actuated bronze Bourdon tube type, cast aluminum 4-1/2" diameter flanged ease, stainless steel movement with bronze bushing, brass socket, and black numerals on a white face.
2. Braided capillary tube and sensing bulb shall be stainless steel and fully ambient compensated for its entire length. Sensing bulb to be installed in a extension neck brass separable socket. Extension neck length to be coordinated with insulation thickness.
3. Accuracy 1% of scale range.
4. Scale to be selected so that normal operating point is between 35% and 65% of full scale.
5. Thermometers to be installed as shown on plans.
6. 

Manufacturer	Series
H.O. Trerice	M80300
U.S. Gauge Supertherm	9100.
Weksler Instruments	415A.



2.19 HOT WATER RADIANT HEATING PANELS:

1. Provide hot water radiant ceiling panels and accessories of sizes, types and capacities as indicated on Drawings and as herein specified.
2. Quality Assurance
  - a. The mechanical contractor shall furnish all labor, materials, tools, equipment, appliances and services necessary to deliver and install all radiant panels as defined.
  - b. Supplier shall submit complete shop drawings showing lay outs, fixing details and piping details of all areas where radiant panels are indicated. These drawings shall be coordinated with, and interference cleared with other trades.
3. Radiant panels shall be manufactured of extruded aluminum with electrostatic acrylic powder paint to 2.0 to 2.5 mils. Panel face configuration shall be V-grooved. The panel shall consist of interlocking extruded sections with steel channel cross braces attached by steel assembly clips. Each section shall have at least one integral heat saddle with a 5/8 inch copper tube mechanically reformed into the heat saddle such that the tube is in intimate engagement. A non-hardening heat conductive paste shall be applied between the copper tube and the aluminum extrusion. The ends of the tubes shall be sized to accept 5/8 inch type L or M soft copper tubing without the need for fittings.
4. Panels shall be designed to allow field modifications such as shortening overall length, mitering, etc. Panels shall be trimmed to run wall to wall to minimize joints. Manufacturer shall furnish all special tools required for installation or modification of the panel.
5. Panel manufacturer shall supply 360 degree pigtail interconnects and U-bends 0.500 inch inside diameter as required. Interconnections shall be designed for installation without fittings.
6. Hangers shall be installed not over 4 feet on center. Panels shall be installed in accordance with manufacturer's recommendations. Panels shall be suspended from the structure as indicated on drawings.
7. Insulation above panels shall be 1-inch thick fiberglass pads, 0.75 lbs/sq. ft. density.
8. All interconnecting piping shall be pressure tested. Pressure test shall consist of nitrogen gas at a pressure of 100 psig for a minimum of 4 hours. No loss in pressure shall occur during the test.
9. Hold down clips shall be installed at wall channels and T-bars to secure the panel and provide a flat even appearance.
10. Shop drawings shall consist of 1/8 inch scale layouts showing layout and complete details for installation.

- 11. Manufacturer:  
Aerotech  
Sun-El  
Airtex

2.20 UNDERGROUND PRE-INSULATED PIPING

- 1. Internal piping shall be ASTM A106B seamless black steel, schedule 40. All joints shall be butt-welded for 2½ inches and greater, and socket or butt-welded for 2 inches and below. Where possible, straight sections shall be supplied in 40-foot random lengths with piping exposed at each end for field joint fabrication.
- 2. Service pipe insulation shall be injected into the PVC casing annular spaces. The polyurethane foam insulation shall completely fill the casing. The polyurethane foam shall be 0.16k-factor, r141b blowing agent, nominal 2 pound per cubic foot density. The following are the minimum casing sizes:

Pipe Size	Casing Size
¾ to 1.25"	3"
1½ & 2"	4"
2.5 & 3"	5"
4 & 5"	8"
6"	10"
8"	12"
10"	14"

- 3. Finish: all preinsulated sections shall have PVC casing of 60mils for casing size 3", 70mils for 4", 80mils for 8", 100mils for 10", 120mils for 12" and 140mils for 14". All fittings and anchors of the insulated piping system shall be prefabricated to job dimensions. No field insulated kits will be allowed
- 4. Accessories: end seals, gland seals and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system
- 5. The manufacturer shall custom engineer and fabricate the underground piping system based on specific project conditions. This shall include, but not be limited to, expansion pads, support-guides, anchor assemblies, expansion loops (if required), etc.
- 6. Installation:
  - a. The internal pipe shall be hydrostatically tested to 150 psig or 1½ times the operating pressure, whichever is greater. Insulation shall then be poured in place into the field weld area. All field applied insulation shall be placed only in straight sections. Field insulation of fittings shall not be acceptable. The mold for the polyurethane shall be made of clear adhesive backed polyester film. The installer shall seal the field joint area with a heat shrinkable adhesive backed wrap. All insulation and coating materials for making the field joint shall be furnished by the piping system manufacture.

- b. A 4-inch layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the pipe. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6-inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil. Place detection tape at minimum depth of 18" directly above piping.
  - c. Factory trained field technical assistance shall be provided for critical periods of installation; unloading, field joint instruction and testing. On completion of the installation, the contractor shall deliver to the owner a certificate from the manufacturer stating that the installation has been made in accordance with the manufacturer's recommendations.
7. Manufacturer:
- Perma-pipe terra-gard
  - Urecon
  - Thermacore feero-therm
8. Service:
- Chilled Water (underground) piping
  - Hot Water (underground) piping
  - Glycol Hot Water (underground) piping

### PART 3 - EXECUTION

#### 3.01 PIPING INSTALLATION - GENERAL

- 1. Provide and erect in a workmanlike manner, according to the best practices of the trade, all piping shown on the drawings or required to complete the installation intended by these specifications.
- 2. The drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions.
- 3. This Contractor shall inform himself from the general construction specifications and plans, of the exact dimensions of finished work and of the height of finished ceilings in all rooms where radiation, units, equipment or pipes are to be placed and arrange his work in accordance with the schedule of interior finishes, as indicated on the architectural drawings.
- 4. All piping shall be run perpendicular and/or parallel to floors, interior walls, etc. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance. All valves, controls and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.

5. All pipe lines made with screwed fittings must be provided with as sufficient number of flanges or unions to make possible any taking down of the pipes without breakage of fittings.
6. All piping shall be erected so as to insure a perfect and noiseless circulation throughout the system. No bull head tees will be permitted.
7. All valves and specialties shall be so placed as to permit easy operation and access and all valves shall be packed at the completion of the work before final inspection.
8. Provide proper provisions for expansion and contraction in all portions of pipe work, and to prevent undue strains on piping or apparatus connected therewith. Provide double swings at riser transfers and other offsets wherever possible, to take up expansion. Arrange riser branches to take up motion of riser.
9. Approved bolted, gasketed, welded flanges shall be installed at all apparatus and appurtenances, and wherever else required to permit easy connection and disconnection. Screwed unions shall be used on piping 2" or less.
10. All piping connections to coils and equipment shall be made with offsets provided with screwed or welded bolted flanges so arranged that the equipment can be serviced or removed without dismantling the piping.
11. If after plant is in operation, any coils or other apparatus are stratified or air bound (by vacuum or pressure) they shall be repiped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, this trade shall bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.
12. Make all changes in size and direction of piping with fittings. Do not use miter fittings, face, or flush bushing, close nipples or street elbows. Provide clean outs at all changes in direction and at other locations shown in drainage piping.
13. Make all branch connections with tees, except that on steel piping forged steel "Weldolets" as manufactured by Bonney Forge may be used where the branch pipe is not larger than one half the size of the main pipe.
14. Tubing shall be erected neatly in a workmanlike manner. Bends in soft copper tubing shall be made with approved tubing benders to prevent deformation of the tubing in the bends. Approved seat-to-pipe threaded adapters shall be provided for junctions with valves and other equipment having threaded connections.
15. Vertical sections of main risers shall be constructed of pipe lengths welded together. No couplings shall be used.
16. The ends of all pipe and nipples shall be thoroughly reamed to the full inside diameter of the pipe and all burrs formed in the cutting of the pipes shall be removed.

17. Piping shall be installed in accordance with the latest edition of the ASME Code for pressure piping, and all other applicable codes.
18. All piping shall be concealed above furred ceilings in rooms where such ceilings are provided (except where specifically indicated otherwise on the drawings), or walls or partitions, except as otherwise indicated.
19. Dissimilar piping shall be connected with dielectric connector as made by Ebco Company.
20. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.
21. Pipe nipples - any piece of pipe 3" in length and less shall be considered a nipple. All nipples with unthreaded portion 1-1/2" and less shall be extra heavy. Only shoulder nipples shall be used. No close nipples will be provided.
22. Screw threads shall be cut clean and true; screw joints made tight without caulking. No caulking will be permitted. A non-hardening lubricant will be permitted. No bushings shall be used. Reductions, otherwise causing objectionable water or air pockets, to be made with eccentric reducers or eccentric fittings. All pipe shall be reamed out after cutting to remove all burrs.
23. Pitch water piping upward one inch per 100 feet in direction of flow to ensure adequate flow without air binding, and to prevent noise and water hammer.
24. Pitch drain piping 1/8 inch per foot in the direction of flow.
25. Branch connections to mains are to be made in such a manner as to prevent air trapping and permit free passage of air. To meet job conditions mains shall be set up to maintain headroom, and clear other trades.
26. Provide air vents at all high points in water piping. Provide oversized float operated automatic air vent at high points of equipment connections and in mechanical rooms or as shown on piping details. Provide manual vents at all other locations. When installed above inaccessible ceilings, valves shall be installed remote and identified on valve tag chart.
27. Avoid 90 degrees lift set-ups in supply lines by using 45 degree ells. Where 90 degree lifts exceed 12" install automatic air vent in supply lines. All lifts in return lines shall be installed with automatic air vents.
28. Pipe outlet of all air vents to an open sight drain if the vent is concealed or to within two feet of the floor within Machine Rooms.
29. All water piping shall pitch back to low points for drainage. Low points shall be provided with 3/4 inch hose cocks.

30. Provide drain valves at the heel of all interior main water risers. Provide drain valves at the heel of all perimeter water risers if shown on drawings. Pipe all drain valves to an indirect waste.
31. Miscellaneous drains, vents, reliefs, and overflows from tanks, equipment, piping, relief valves, pumps, etc., shall be run to the nearest open sight drain or roof drain. Provide drain valves whenever required for complete drainage of piping including the system side of all pumps.
32. Where pipe penetrates walls, partitions or slabs provide Schedule 40 steel sleeves with an internal diameter at least 2" larger than the outside diameter of the pipe. Set sleeves before pouring concrete or securely fasten and grout with cement. Floor sleeves shall project 1" above the finished floor. Pack void between pipe and sleeve with an approved firestop material. See Section 230000.
33. Provide escutcheons fastened to pipe and covering sleeve on all penetrations visible within occupied spaces, corridors, and mechanical equipment rooms. Escutcheons are to be chrome plated brass, Ritter No. 36A for vertical lines, Ritter No. 3A for all other piping.
34. Cross connection of any devices, or construction which will permit backflow connections between a water distribution system and any part of the drainage system shall not be installed.
35. Provide domestic water connections from valved outlets to any equipment requiring same.
36. Keep piping 2'-0" outside the vertical line of unprotected electrical equipment, or provide painted, watertight gutters or pans with pipe drains.

### 3.02 PIPING SUPPORT

1. Piping shall not be hung from other piping or from equipment of other trades.
2. Piping installed in existing buildings (or in new buildings where additional supports are required), shall be hung from supplemental steel attached to and spanning the existing (or new, in new buildings) steel structure or with chemical adhesive anchors. Use of vertical expansion shields shall not be permitted. Where vertical support into masonry or concrete structure cannot be avoided, use supplemental steel as noted above, or use chemical adhesive anchors.
  - a. When attaching to existing concrete structure (or newly placed structure where additional supports are required), provide two chemical adhesive anchors at each support point. The chemical anchors shall be separated by a minimum of 8". A 2.5x2.5x3/8 angle iron shall span the two chemical anchors. Drilling for chemical adhesive anchors must not interrupt or displace any existing rebar. Concrete insert shall be either external or internal threaded element by the chemical adhesive manufacturer.
  - b. When attaching to concrete rib construction, the chemical anchors shall be attached to the upper third of the rib. Do not attach to the bottom of concrete ribs.

- c. Minimum chemical anchor embedment shall be 3". The two chemical adhesive anchors shall be the same diameter as the attachment rod.
  - d. Chemical adhesive product for solid concrete applications shall be Hilti HIT RE 500 with either internally threaded inserts or threaded rod supplied by the chemical adhesive manufacturer. Inserts to be similar to Hilti HIS. Threaded rod to be similar to Hilti HAS product.
- 3. Hanger rods shall not pierce ducts.
  - 4. All piping connected to pumps and compressors within 50 feet of such equipment, and where required or directed to eliminate vibration or isolate pipe from building structure, Contractor shall supply and install spring type antivibration isolators as called for in Section 230548 of these specifications.
  - 5. Where additional steel is required for the support of hangers, the Contractor shall furnish and install same subject to the approval of the Architect.
  - 6. All piping running on walls shall be supported by means of hangers suspended from heavy galvanized steel angle wall brackets. No wall hooks will be permitted.
  - 7. Lateral bracing of horizontal pipe shall be provided where required to prevent side sway or vibration. The lateral bracing shall be of a type approved by the Architect and shall be installed where directed by the Architect.
  - 8. All horizontal copper tubing shall be supported by hangers not over 6' apart for piping 1-1/4" and smaller. Space hangers no more than 10' apart for piping 1-1/2" and larger. All branches shall have separate hangers. Hangers shall be Clevis type (with copper bottom support for uninsulated brass pipe or copper tubing). If channel or angle iron trapeze hangers are used, the space on the hangers for uninsulated brass pipe or copper tubing shall be wrapped with lead shields to isolate tubing.
  - 9. Hanger rods attached to concrete inserts or piping racks shall not be used to support piping in Mechanical Rooms or for the support of individual pipes weighing in excess of 20 lbs. per linear foot.

### 3.03 PIPING JOINTS

- 1. Welding
  - a. Joints between sections of pipe and between pipe and fittings shall be fusion welded in accordance with the recommendations of the American Welding Society. Mitering of pipe to form elbows, matching straight runs to form tees or any similar construction shall not be done.
  - b. All welding shall be done as outlined in the latest edition of the ASME Code for pressure piping.
  - c. Welding process - all welding shall be done by the oxyacetylene or electric arc welding process in accordance with the requirements set forth in welding of pipe joints of the codes for pressure piping.

- d. Beveling and welding - all pipe 2-1/2 inches and larger may be purchased mill beveled or shall be machine beveled on both ends before welding. On odd lengths of pipe, beveling may be accomplished by means of the oxyacetylene cutting torch provided all paint, rust, scale and oxide are carefully removed with hammer, chisel or file and bevel left smooth and clean. Joints shall be prepared and welded to assure thorough fusion of alignment and the production of a joint that shall develop the full strength of the pipe and that shall be leakproof in service.
  - e. Welding tees - welding tees shall be used when specified hereinafter. Where necessary, branch connections shall be reinforced in an approved manner. For the smaller branches, where welding tees are unavailable, nozzles shall be welded to pipe. Where such nozzles are welded to the pipe, all cutting oxide which may drop inside the pipe shall be removed before welding the branch or section in place. Where branch size is one half the size of main or larger, use welding tees. Where branch size is two (2) sizes smaller than the size of main "Weldolets" or "Sockolets" may be used.
  - f. Welding rods - the welding rod used for welding steel and wrought iron shall be approved welding rod in accordance with ASTM SPEC. A233.
  - g. Welder shall be fully certified by the authorities having jurisdiction to certify welders for pressure piping.
2. Flanged Joints
- a. Use matched flange faces and 1/16" thick compressed gaskets.
  - b. When connection to equipment with flat face flange, grind flange raised face flat and use full faced gaskets.
3. Screwed Joints
- a. Do not damage fitting surface, remove burrs, apply red lead and ground graphite in linseed oil to male threads only. Do not use wicking, cord or similar materials. Clean joint thoroughly of excess jointing material.
4. Soldered Joints
- a. 95-5 wire solder. Completely clean all surfaces and coat with a thin layer of flux.
5. Brazed Joints
- a. Conform to ASA-B31.1 and ASTM B-260-56T in accordance with the requirements of the manufacturers of the fittings and the brazing material.

### 3.04 CLEANING OF PIPING

- 1. Plug all open ends of piping, valves and equipment except when work is being performed. Protect connections to equipment and control valves with temporary screens and flush piping with water. Remove dirt and debris collected.



2. Thoroughly clean the piping to remove all organics, rust, and all foreign matters and to prepare the system for permanent treatment.
3. Perform chemical cleaning after completing all pressure and leakage tests and thoroughly flushing the systems.
4. Use cleansing agent which will not interact with any of the materials in the systems in any way to produce corrossions, form deposits, weaken, reduce the life or in any way have a detrimental effect on any system components.
5. Fill the system with clean water and add sufficient cleaning preparation to provide a concentration adequate to perform complete cleaning. Add the cleaning preparation at a point which will assure good mixing.
6. Provide temporary containers to accommodate the foam that may form and temporary pumps to circulate the chemical solution.
7. Circulate the mixture of cleanser and water for a sufficient length of time to complete the cleaning.
8. Drain the system, flush with clean water, clean all strainers and screens and refill the system.
9. Cleaner for the new piping shall be Nalprep 330 as manufactured by the Nalco Chemical Co., or the approved equal.
10. Entire cleaning operation shall be performed by a competent water treatment service in strict accordance with the manufacturer's recommendations. Provide written certifications after the cleaning operation is complete.
11. All new and existing piping to remain shall be cleaned as per this section.

### 3.05 TESTS

1. Tests all piping except drainage connections, including valves, fittings and joints hydrostatically at a pressure equal to at least 1-1/2 times the rated pressure, but no less than 200 psig for a minimum of four hours. Blank-off or remove all elements or equipment which may be damaged by the pressure. Open but do not back-seat valves. Inspect all joints and connections.
2. Test drainage piping hydrostatically and with smoke in accordance with the local authorities.
3. Repair all leaks, defects or damage revealed by resulting from the test and re-test the system.
4. Do not insulate or conceal piping until the system has been tested and the results approved.

5. Perform tests in the presence of the Engineer and the Building Official.

### 3.06 AIR ELIMINATION

1. The Contractor's attention is specifically directed to the problem of proper air elimination. In installing water piping systems and all equipment, the Contractor shall carefully plan the actual installation in such a manner that high points and air pockets be kept to a minimum and that they are properly vented where they are unavoidable. All air elimination devices called for on the drawings and in these specifications shall be provided and properly installed. In addition, this Contractor shall furnish and install all other air elimination devices which may be required due to job conditions. The liability of the Contractor under the guarantee provisions of the contract is intended to cover his responsibility for a proper, continuous and automatic air elimination to assure even and balanced distribution of water to all equipment.

### 3.07 ANCHORS

1. All anchors shall be separate and independent of all hangers and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work of this contract. Anchors shall be welded to the pipe and fastened to the structure with bolts.
2. Anchors shall be fabricated and assembled in such a form as to secure the piping in a fixed position. They shall permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points; and shall be so arranged to be structurally suitable for particular location, and line loading. Submit details for approval.

### 3.08 REFRIGERATION PIPING TESTS

1. Test refrigeration piping for tightness with CO<sub>2</sub> at 150 PSIG for low side and 150% of maximum operating pressure for the high side, but in no case lower than 400 PSIG. Test the joints with R-22 at 5 PSIG and inspect the joints with an electronic halide leak detector set to maximum sensitivity. There shall be no detectable leaks or drop in pressure.
2. After the refrigeration piping has been tested under pressure, use a vacuum pump to reduce the pressure inside the system to a vacuum of 29.75 inches of mercury and maintain this vacuum for at least 48 hours. Charge the system through the dehydrator immediately after successful completion of the vacuum test.
3. The manufacturer of the equipment shall perform all field testing and final adjustment of the refrigeration apparatus in accordance with provisions of the applicable ASHRAE Standards and 2003 IMC Section 1108.

### 3.09 WATER BALANCE

1. Balance all new water systems and those designated existing water system to the quantities shown with the following tolerances:

Pumps:	Design Flow plus 5%
Coils:	Design Flow plus 5%

2. Balance in accordance with ASHRAE, AABC, or NEBB procedures and submit all readings.
3. Water system balancing is to be performed by a professional organization, other than the installing contractor, qualified by experience and practice to perform this service. Submit evidence of qualifications, balancing procedures, and report forms for approval prior to start of work.
4. Submit three bound copies of the water balance report to the Engineer. Balance Report to include the following data for each water system:
  - a. Pump Designation, location, system type.
  - b. Manufacturer, model number, size.
  - c. Suction and discharge pressure readings.
  - d. Balancing valve position.
  - e. Motor manufacturer, frame, horsepower, volts, phase, hertz, and RPM.
  - f. Motor amps - Design versus Actual.
  - g. Water coil GPM, entering water temperature, leaving water temperature and pressure drop (Design versus Actual) - Balancing valve position.
  - h. Tube bundle GPM, entering water temperature, Leaving water temperature, and pressure drop (Design versus Actual) - Balancing valve position.
  - i. Steam coil entering pressure, flow rate, air quantity, entering and leaving air temperature.

END OF SECTION

SECTION 23 05 48 - EQUIPMENT BASES AND VIBRATION CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Vibration isolation equipment.
  - b. Submittal data shall include complete mounting details of each isolated piece of equipment, including static deflection, operating and free heights, and outside spring diameter.
  - c. Steel bases and concrete inertia bases shall be completely detailed.
  - d. Include clearly outlined procedures for installing and adjusting the isolators.
  - e. Performance report and calculations for vibration isolation equipment.
  - f. Manufacturers' certified reports on motorized equipment alignment and installation.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000.

**PART 2 - PRODUCTS**

**2.01 VIBRATION ISOLATIONS, GENERAL**

1. All mechanical equipment shall be mounted in accordance with the specifications below and with the specific requirements shown in the equipment schedules. The vibration isolation manufacturer shall provide supervision to ensure proper application, installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer shall make a final inspection and report. The Contractor shall submit this report to the Architect, in writing, certifying the proper performance of the installation.
2. The isolation manufacturer shall supply all unit isolators, complete rails, fan and motor bases and structural steel forms for concrete inertia blocks, where called for, and shall be responsible for the selection of all vibration eliminators and shall guarantee to meet the requirements of this specification.
3. Wherever rotational speed is mentioned as the disturbing frequency the lowest such speed in the system shall be used. All isolation devices shall be selected for uniform static deflections according to distribution of weight.
4. Vibration isolators shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated, or phosphated and painted with rust-resistant enamel. Nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with metal etching primer and painted with rust-resistant enamel. Isolators exposed to the weather shall have all steel parts hot-dipped galvanized. Nuts, bolts and washers may be cadmium plated. Spring components shall be cadmium plated and neoprene coated.
5. All fan units and air handling units (except fans mounted on slab on grade) shall be isolated as follows:

a.	Up to 450 RPM	75% efficiency (3-1/2" max. defl.)
b.	450 RPM to 850 RPM	90%
c.	850 RPM and Over	95%
6. Submittals shall show disturbing frequency, required efficiency, designed deflection and outside diameter of springs, when pertinent.
7. Horizontal pipe runs - all horizontal pipe runs within Mechanical Equipment Rooms and within 50 feet of final connections to all equipment having motors of 1/2 horsepower or larger, shall be isolated from building structure by means of spring hanger units designed for insertion in rods.
8. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

9. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
10. The ratio of lateral to vertical stiffness shall be not less than 0.9 nor greater than 1.5.
11. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than + 10%.
12. All neoprene mountings shall have a shore hardness of 40 to 65, after minimum aging of 20 days or corresponding oven-aging.

2.02 MOUNTINGS

1. Type A - double deflection neoprene mountings shall have a minimum static deflection of 0.35 inches. All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for those areas where bolting is required. On equipment such as small vent sets, steel rails shall be used above the mountings to compensate for the overhang.

MANUFACTURER	TYPE
Amber Booth	RVD
Korfund	WSC and TR Rails
Mason Industries, Inc.	ND and Rails RND
Vibration Eliminator Co.	T44 and D-Rails
Vibration Mountings	RD and DRB Rails

2. Type B - spring isolators shall be free-standing and laterally stable without any housing and complete with 1/4" neoprene, acoustical friction pads between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Minimum static deflection: 1.0". Static deflection shall be selected. Required efficiency is attained throughout entire operating range.

MANUFACTURER	TYPE
Amber Booth	SW-1
Kinetics	FDS
Korfund	WSCS
Mason Industries, Inc.	SLF
Vibration Eliminator Co.	OSK
Vibration Mountings	Spring-Flex Series "A"

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3. Type C - double neoprene in shear type within a steel housing suitable for suspension rod mounting. Minimum static deflection of 0.4"

MANUFACTURER	TYPE
Amber Booth	BRD
Kinetics	FLS
Korfund	Elastomer Series "H"
Mason Industries	HD
Vibration Eliminator Co.	3CD
Vibration Mountings	RHD

4. Type D - steel compression springs as described in paragraph above and neoprene sound absorbing element mounted in a steel housing, suitable for suspension mounting. Minimum spring static deflection of 1.0".

MANUFACTURER	TYPE
Amber Booth	BSR, PBSR
Kinetics	SFH/SRH
Korfund	VIBRO Type "VX"
Mason Industries	PCDNHS
Vibration Eliminator Co.	SNRC2
Vibration Mountings	RSHP

5. Type E - ribbed rubber or neoprene isolator pads loaded to 40 pounds per square inch. 1/4" thick steel baseplate. Minimum double pad with 16 gauge steel separator plate. Maximum pad loading of 50 psi; minimum pad static deflection of 0.1" when loaded.

MANUFACTURER	TYPE
Amber Booth	SP-NR
Korfund	KOR PAD-40
Kinetics	NPD
Mason Industries	WSWSW
Vibration Eliminator Co.	100 N
Vibration Mountings	SHEAR-FLEX

6. Type F - vibration isolation manufacturer shall furnish integral structural steel bases. Bases shall be in a rectangular shape except for pumps which may be tee-shaped. Pump bases for split case pumps shall include supports for suction and discharge base elbows. All perimeter members shall be equal to 1/10 longest span. Provide height saving brackets in all mounting locations. Fill base with reinforced concrete and mount on concrete sub-base. Provide a 1" minimum operating clearance below base. Minimum static deflection - 1-1/4".

MANUFACTURER	TYPE
Amber Booth	WSB-HS
Korfund	L
Kinetics	SFB/FBB

Mason Industries	K
Vibration Eliminator Co.	OSK
Vibration Mountings	WFB

7. Type G - vibration isolators shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated, or phosphated and painted with rust-resistant enamel. Nuts, bolts and washers may be cadmium plated. Spring components shall be cadmium plated and neoprene coated. The isolators shall have vertical and lateral stops. The springs shall be selected to provide minimum 2" deflection. The installing contractor shall provide and install steel beams of adequate size, strength and quantity to span between the isolators and to produce the necessary continuous support for the towers. Isolators shall include matched tapped holes in the top plate for fastening to equipment.

MANUFACTURER	TYPE
Amber Booth	CT
Korfund	WSCL
Mason Industries	SLR
Vibration Eliminator Co.	KW
Vibration Mountings	AWR

8. Type H - Seismic snubbers shall be located at each spring mounted piece of equipment. A minimum of four snubbers per piece of equipment. The snubber shall consist of interlocking steel members restrained by a shock absorbent material. The absorbent material shall be at least 3/4" thick and installed with a minimum 1/8" clearance. Snubbers shall withstand forces four (4) times the loads applied to the equipment mounts.

MANUFACTURER	TYPE
Amber Booth	ER
Mason Industries	Z-1011, 1225
Kinetics	HS

9. Type I – Rooftop isolation rails, to fit between roof curb or supports, and the supported equipment. Rails shall follow outline of supported equipment perimeter, including valve extension housings. Extruded aluminum top and lower members. Upper member shall have an overlapping aluminum weather shield. Weather seals shall consist of neoprene seal above and below the rails, with flexible EPDM or neoprene connection between upper and lower rail. Springs shall be cadmium plated, minimum 3/4" deflection with 3/4" additional travel to solid. Spring diameters shall be minimum 0.8 of spring height at rated load. Wind resistance shall be via snubbers in corners with minimum 0.25" clearance to springs.

MANUFACTURER	TYPE
Amber Booth	RTIR
Mason Industries	CMAB
Kinetics	KSCR



2.03 ISOLATION SCHEDULE

EQUIPMENT TYPE	ISOLATION TYPE
Chiller	B, E, F, H
Pumps	B, E, F, H
Cooling Tower	G, H
Rooftop Curb Mounted Air Handling Units	I
Suspended Fans	D
Suspended Chilled Water Piping	D
Suspended Hot Water Piping	C
Suspended Condenser Water Piping	C
Refrigeration Piping	C*
Unit heaters	C
Volume Boxes	C
Utility Set	A

\* Provide isolators on the entire run.

PART 3 - EXECUTION

3.01 BASES AND SUPPORTS - GENERAL

1. Provide accurate templates showing all openings for anchor bolts, drains and other required openings and detailed installation instructions for equipment and motor bases and supports.
2. Align all equipment level throughout. Provide shims to facilitate pipe connections and leveling.
3. Position the isolation units in accordance with the load distribution. Locate isolation mounts so that the load, including the drive, is supported over or between the mounts with no overhang.
4. Construct all suspended or wall hung isolators, supports and accessories including hangers, cradles and wall brackets to sustain a load of at least five times the actual operating load.

END OF SECTION

SECTION 23 07 00 - INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.
2. Conform to applicable performance standards, listings or approvals of the following organizations.
  - a. National Fire Protection Association (NFPA)
  - b. Underwriters Laboratories (UL)
3. All insulating materials shall comply with the following ratings:
  - a. Flamespread -25
  - b. Smoke Developed -50
  - c. Fuel Contributed -50

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Insulating materials and jackets.
  - b. Insulating cements, mastics and adhesives.
  - c. Methods of installation.
  - d. Pump enclosure details.
  - e. Pipe shields.
  - f. Schedule of insulation (system, material, thickness, cover, method of installation).

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

1. Type A - Fiberglass Insulation

- a. The insulation should be sectional pipe jacketed with an embossed barrier laminate. 3.5 pound density insulation with a maximum thermal conductivity(k) of 0.29 Btu-in/hr-ft<sup>2</sup>-°F and rated to 850°F, composed of glass fibers bonded with a thermosetting resin. Insulation to be faced with vapor barrier of white flame resistant UL rated Kraft paper bonded to reinforced aluminum foil. Vapor barrier to have a maximum permeance of 0.02 perms.

b.	Indoor Piping	Pipe Size:		
			1-1/2" & smaller	Over 1-1/2"    Fitting Type
	Service:			Thickness (in.):
	Hot Water (<200°F)	1-1/2"	2"	F
	Glycol Hot Water	1-1/2"	2"	F
	Chilled Water	1-1/2"	1-1/2"	G
	Condenser Water	1/2"	1/2"	G
	Condensate Drains	1/2"	1/2"	G
	Water Make-up	1/2"	1/2"	G
	Chemical Treatment	1/2"	1/2"	G
	Domestic Water	1"	1"	G
	Horiz. Roof Drains	1"	1"	G
	Refrigerant	1 1/2"	1-1/2"	G

- c. Manufacturers:  
 Owens-Corning, SSL II  
 Johns Manville - Micro-Lok  
 Knauf 1000° Pipe Insulation

2. Type B - Foam Insulation

- a. 25/50 - rated premolded flexible elastomeric foamed plastic with 2 pounds nominal density max. K = .3 at 100°F, mean and operating temperature of -40°F to +200°F.

b. Service: Thickness:  
Refrigerant (outdoors) 1"

c. Manufacturers:  
Armstrong - Type AP ARMAFLEX  
Nomaco, Inc. - Type THERMA-CEL  
Armacell – Type Armaflex

3. Type C - Foamglass Insulation

a. 8.5 PCF average density, 100 psi compressive strength, max K = 75 °F mean, and operating temperature -320°F to 300°F, rigid glass cells. Minimum R-Value of R-8.

Service:	Thickness:
Outdoor Piping	
Condenser Water	2"
Water Make-up	2"
Exterior Ductwork	4" (2 layers of 2" each)

b. Manufacturers:  
Pittsburgh-Corning, Type H/L.B. Foamglas  
Upjohn - Type CPR Trymer L  
SPI - Foamglas

4. Type D - Calcium silicate

a. Asbestos free, rigid hydrous calcium silicate, rated to 1200°F operating temperature.

Minimum density = 12 PCF.

Maximum conductivity = .4 at 200°F mean.6 at 600°F, mean

Service:	Thickness:
Generator Exhaust	2"
Generator Muffler	2"
Convertors	2"

c. Manufacturers:  
Owens-Corning, Kaylo 10  
Manville, Thermo 12  
IIG, Thermo-12 Gold

5. Type E - Aluminum Jacketing
  - a. 016" aluminum jacket lock-on or slip-on type jacketing to be covered with acrylic coating on one outer surface and the baked epoxy moisture barrier on the inner surface.
  - b. Service:  
Outdoor Piping on Type C Insulation
  - c. Manufacturer: Childers Products Co. - Lock-on or slip-on type.
  
6. Type F - Fiberglass insulation for valves/fittings/flanges (other than vapor seal insulation).
  - a. Molded factory-formed fibrous glass with 3.5 PCF minimum density, max. K = .3 at 200OF, mean, rated to 450OF. All joints to be sealed with vapor.
  - b. Finish with white 0.020", 25/50 rated PVC jacket, as manufactured by Proto LoSMOKE, or approved equal. Fitting covers and jacketing to be precurled.
  - c.
 

Service:	Thickness:
Condensate	Same as Piping
Hot Water	Same as Piping
Glycol Hot Water	Same as Piping
  - d. Manufacturers:  
Fibrous Glass Products, Inc.  
Insulcoustic Corp.  
Hamfab
  
7. Type G - Fiberglass insulation for valves, fittings, flanges (vapor seal insulation).
  - a. Molded, factory-formed fibrous glass with 3.5 PCF minimum density, max. barrier adhesive and wrapped with glass mesh tape. Each fitting to be finished with two coats of Benjamin Foster 30-36 vapor seal.
  - b. Finish with white 0.020", 25/50 rated PVC jacket, as manufactured by Proto LoSMOKE, or approved equal. All joints between PVC jacket and pipe covering shall be sealed with vapor barrier tape. Fitting covers and jacketing to be precurled.
  - c.
 

Service:	Thickness:
Chilled Water	Same as piping
Condenser Water	Same as piping
Water Make-up	Same as piping
Domestic Water	Same as piping
Roof Drains	Same as piping

- d. Manufacturers:  
Fibrous Glass Products, Inc.  
Insulcoustic Corp.  
Hamfab
8. Type H - Blanket/wrap
- a. One(1) pound density insulation with a maximum thermal conductivity(k) of 0.27Btu-in/hr-ft<sup>2</sup>-°F at 75<sup>0</sup>F, composed of glass fibers bonded with a thermosetting resin. Insulation to be faced with vapor barrier of reinforced aluminum foil bonded to flame resistant UL rated Kraft paper. Vapor barrier to have a maximum permeance of 0.02 perms.
  - b. Service: Thickness:  
Concealed Ductwork  
Supply Air 1 1/2"  
Outside Air 1 1/2"  
Exhaust Air downstream  
& 5' upstream 1 1/2"  
of motorized damper.
  - c. Manufacturers:  
CertainTeed Soft Touch duct wrap with FSK facing.  
Johns Manville Microlite duct wrap with FSK facing.  
Knauf – Duct Wrap with FSK jacket.  
Owens-Corning Fiberglass – Type 100 all service duct wrap.
9. Type I - Duct Board
- a. Six(6) pound density insulation with a maximum thermal conductivity(k) of 0.23Btu-in/hr-ft<sup>2</sup>-°F at 75<sup>0</sup>F, composed of glass fibers bonded with a thermosetting resin. Insulation to be faced with vapor barrier of reinforced aluminum foil bonded to flame resistant UL rated Kraft paper. Vapor barrier to have a maximum permeance of 0.02 perms.
  - b. Service: Thickness:  
Exposed ductwork  
Supply Air 1"  
Outside Air 1"  
Exhaust Air downstream 1"  
& 5' upstream  
of motorized damper.
  - c. Manufacturers:  
CertainTeed – CertaPro Commercial Board.  
Johns Manville – Spin-Glas Board  
Knauf - Insulation Board

10. Type J - Fiberglass for tanks and accessories.
- a. Three pounds density, 450<sup>o</sup>F max. operating temperature, K Max = .3 at 200<sup>o</sup>F, mean semi-rigid board fibrous glass insulation, unfaced.
  - b. Service: Thickness:
    - Inline air separators 1"
    - Irregularly shaped pipe accessories 1"
    - Condensate Pump Receivers 1"
    - Expansion Tank 1"
  - c. Manufacturers:
    - Owens-Corning, Type 703
    - Certainteed, Type IB
    - Knauf, Type elevated temperature board.
    - Manville, Type Spin Glass
11. Type K - Pump Enclosures
- a. Enclose pumps with an 18 gauge galvanized steel enclosure lined with a max. K = .3 at 75<sup>o</sup>F, mean, 2" thick, 6# density rigid mineral fiber.
  - b. Service:
    - Chilled Water Pumps
    - Condenser Water Pumps
  - c. Manufacturers:
    - Owens-Corning, Type 705
    - Manville, Type 800
    - Certainteed, Type iB600
12. Type L - Fire Resistive Duct Wrap
- a. Non-asbestos lightweight, high temperature, inorganic material consisting of ceramic fiber blanket with continuous foil-scrim jacket.
  - b. Service temperature of 2300<sup>o</sup>F. Suitable for zero clearance to combustible material.
  - c. Service: Thickness:
    - Kitchen exhaust ductwork 1-1/2" in multiple layers  
necessary for a two hour rating.
  - d. Manufacturer:
    - Minnesota Mining and Manufacturing, FireMaster Duct Wrap or the approved equal having received approval from authorities having jurisdiction.

**PART 3 - EXECUTION**

**3.01 INSULATION - GENERAL**

1. All insulating materials shall be applied only by experienced workmen, in accordance with the best covering practice. All piping, duct or equipment shall be blown out, cleaned, tested and painted prior to the application of any covering.
2. At all openings insulation, insulate edges neatly and protect with sheet metal frames.
3. All items below described in general indicate the type of covering required, however, all piping, ductwork or equipment that transmits heat or will form condensation shall be insulated.
4. Insulate all piping, valves, fittings, and accessories that are part of the piping systems specified to be insulated in, but not limited to, specification section 230700, 2.1. Insulate valves and strainers to permit removal of bonnets or baskets without damage to insulation on valve or strainer bodies.
5. Where existing insulation is damaged by requirements of the work, replace all damaged insulation to match existing insulation's thermal value.
6. All insulation at duct access doors shall be set in sheet metal double-pan construction.
7. No piping, ductwork, or equipment shall be insulated until tested and approved for tightness. All piping and ducts shall be dry when covered.

**3.02 APPLICATION - PIPE INSULATION (TYPE A)**

1. Vapor barrier jacket: Seal longitudinal joints with vapor barrier adhesive, transverse joints sealed with vapor barrier strips and adhesive. Ends of pipe insulation sealed off with vapor barrier adhesive at all flanges, valves and fittings, and at not more than 20 feet on continuous runs of pipe.
2. Finish for concealed pipe insulation: Secure all concealed pipe insulation with staples and vapor seal adhesive at longitudinal; standard all service jacket pasted on lap.
3. Finish for exposed pipe insulation: Multiple layers (minimum 2) of glass weave jacket lap sealed with Childers CP-30. Alternatively, finish with white 0.020", 25/50 rated PVC jacket, as manufactured by Proto LoSMOKE, covering over all service jacket. For exposed vapor seal insulation, same finish over vapor sealed all service jacket.

**3.03 APPLICATION - PIPE INSULATION (TYPE B)**

1. Slip pipe insulation over pipe or slit the insulation and apply around pipe. Insulate fittings and valves with fabricated covers of some thickness. Miter all joints and seal with adhesive. Longitudinal seams to be located on top centerline of pipe.



3.04 APPLICATION - PIPE INSULATION (TYPE C)

1. All piping shall be insulated with the proper thickness of Foamglas insulation as shown in the high-temperature thickness table. Insulation thickness shall be determined by highest operating temperature at which the piping normally operates.
2. Foamglas pipe insulation shall be applied to piping dry, in staggered joint fashion with all joints tightly butted. Stainless steel (1/2" x .015") or aluminum (1/2" wide x .020") bands shall be applied on 9" centers when using 18" length pipe covering, and 12" centers when 24" length pipe covering is used. Foamglas sections shall be fitted to eliminate voids. All voids shall be eliminated by refitting or replacing the Foamglas sections.

3.05 APPLICATION - PIPE INSULATION (TYPE D)

1. Application: Cut and miter insulation to fit the shape of the pipe and secure with stainless steel bands, spaced a maximum of 9" on centers. Where required, supplement bands with stainless steel straps and lacing wires. Point joints with cement.
2. Surface finish: Apply high ribbed metal lath and two 1/2" thick coats of vermiculite plaster. Trowel to a smooth finish. Use corner beads on all edges.

3.06 APPLICATION - GENERATOR EXHAUST/MUFFLER (TYPE D)

1. Apply insulation in two layers with staggered joints between layers. Each layer shall be secured with No. 14 gauge stainless steel wire. Apply a high rib lath and two coats of vermiculite plaster over the insulation.
2. Finish the surfaces with .016" thick aluminum jacketing with lock on joints. Provide 12" long, 16 gauge aluminized steel shields at support points.

3.07 APPLICATION - PIPE INSULATION (TYPE E)

1. Install aluminum jacketing with a minimum 2" overlap lapped downward to shed water. Seal all joints with joint sealer mastic. Finish circumferential joints with 3/8" aluminum strapping and seals. Secure with aluminum bands on 8" centers.

3.08 APPLICATION - INSULATION AT PIPE HANGERS

1. Provide pipe hangers insulation protection saddles and shields.
2. Fill each pipe covering protection saddle with same insulation as specified for respective pipe or with suitable insulating cement.
3. Where shields are specified at hangers on piping with fibrous glass covering, provide for load bearing calcium silicate between shields and piping as follows:
  - a. For pipe covering without vapor barrier jacket, furnish at each shield 18" long calcium silicate section with canvas jacket continuous between shield and insulation.

- b. For pipe covering with vapor barrier jacket, remove bottom half section of fibrous glass and replace with half section of calcium silicate. Make vapor barrier jacket continuous between shield and insulation.

3.09 APPLICATION - DUCT INSULATION (TYPE H)

1. Install duct wrap over clean, dry sheet metal ducts. All duct joints and seams must be sealed to prevent air leakage from the duct.
2. Duct wrap shall be cut to stretch-out dimensions. 2" piece of insulation is removed from the facing at the longitudinal and circumferential ends of the piece to form an overlap. Wrap the insulation around the perimeter of the duct with the facing out. Duct wrap shall be compressed a maximum of 25% in order to maintain thermal efficiency. Adjacent sections of insulation shall be tightly butted with the 2" overlapping. Staple seams on 6" centers.
3. Minimize compression of the insulation to assure maximum thermal performance. Longitudinal seam of the vapor barrier must be overlapped a minimum of 2".
4. All seams should be finished with appropriate pressure sensitive tape or glass fabric and mastic.
5. Pressure sensitive tapes should be a minimum 3" wide and be applied with moving pressure using an appropriate sealing tool.
6. Closure systems should have a 25/50 F.H.C. per UL 723.
7. For rectangular ducts over 18" wide, the duct wrap should be secured to the duct with mechanical fasteners spaced on 18" centers to reduce sag. Care should be taken to avoid over compressing the insulation with the retaining washer.
8. Unfaced duct wrap should be overlapped a minimum of 2" and fastened with 4" to 6" nails or skewers spaced 4" apart, or secured with a wire or banding system.
9. Where vapor barrier performance is necessary, all seams, joints, penetrations, washers and damage to the facing should be repaired with a minimum 2" overlap of tape prior to system startup.

3.10 APPLICATION - DUCT INSULATION (TYPE I)

1. Fasten insulation in place with wed pins and washers or equivalent mechanical fastening method, as approved.
2. Seal all joints with vapor barrier adhesive to provide continuous vapor barrier.
3. All edges, corners, penetrations, and joints shall be reinforced and sealed with vapor barrier adhesive tape to provide continuous vapor barrier. Tape shall be 4" wide, of type, and applied in strict conformance with manufacturer's recommendations. Tape shall be applied over insulation support washers.

3.11 APPLICATION OF OUTDOOR DUCT INSULATION

1. All outdoor ductwork shall be insulated with multiple layers of Foamglas insulation totaling at least the thickness indicated. The initial layer shall be slightly larger than the reinforcing angle and/or seams at longitudinal joints. The second layer shall be applied with lapped joints up to the specified thickness.
2. Secure the insulation with adhesive and stainless steel (1/2" x .015") or aluminum (1/2" wide x .020") bands shall be applied on 12" centers. Foamglas sections shall be fitted to eliminate voids. All voids shall be eliminated by refitting or replacing the Foamglas sections. Seal outer joints with Pittseal 111.
3. Apply metal corner beads on the top corners of the insulation. Cover the insulation with reinforced fabric mesh. Apply two coats of bitumastic, Pittcoat 300, over the entire surface of the ducts.

3.12 APPLICATION - TANK INSULATION (TYPE J)

1. Point joints with lagging cement prior to application of finish. Finish with two layers of 8 oz. glass mesh weave. Coat each layer of weave with vapor barrier adhesive.
2. Insulation shall be fastened with welded pins or stick clips on flat surfaces and with stainless steel bands on irregular surfaces.

3.13 APPLICATION - PUMP ENCLOSURE (TYPE K)

1. Fabricate the enclosure with a division coinciding with the pump split case so that part of the enclosure can be removed and the pump serviced and dismantled without destroying the insulation.
2. Fill voids in the interior of the insulated enclosure with scraps of fiberglass insulation.

3.14 APPLICATION - FIRE RESISTIVE DUCT WRAP (TYPE L)

1. Install in accordance with manufacturer's recommendations and approved MEA installation procedures.
2. Encircle the duct with continuous layers of insulation material. The material shall overlap by a minimum of three inches in the perpendicular direction. Subsequent layers of material shall be applied with a minimum three inch overlap in the longitudinal direction. Apply multiple layers as necessary to achieve a two hour zero clearance fire resistance rating.
3. Secure insulation with 304 carbon steel banding (two hour rating) not less than 1/2 inches wide and 0.015 inches thick.
4. Seal edges of insulation with high performance aluminum tape, 3 inches wide,

5. Access doors shall be covered by three layers of insulation secured by 10 gauge pins, 4" to 5" long or copper coated steel, secured by 1-1/2" x 1-1/2" galvanized clips. Insulation shall be applied in three layers, each successive layer shall be 2" larger than the previously applied layer. Seal edges of exposed insulation with three inch wide aluminum tape. Access door shall be secured by 1/4" diameter threaded rods with 1/4" wing nuts, 12 inches on center around the perimeter of the access door.
6. Seal floor penetrations with 3M FB-2000+ silicone sealant over packing material of 3M FireMaster duct wrap or 3 pcf mineral wool.
7. Extend the duct wrap 5" onto the hood in accordance with the manufacturer's recommendations. Secure the insulation with a continuous, minimum two (2) inch wide by 1/8" thick steel bar stock, fastened to the hood 4" on centers. For grease hoods, insulate the entire top of the hood to a thickness of 1-1/2".
8. Insulate all hanger rods directly in contact with the duct, with 8" of ductwrap closest to the point of contact.

END OF SECTION

SECTION 23 09 23 – CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training.
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.
4. Refer to specification division 50. The Commissioning services for Division 23 systems are specified within Division 50 Commissioning. The General Contractor, the division 23 contractor and the GC's Subcontractors shall include all manpower, time, and resources required to accomplish the commissioning as specified.

1.02 SUMMARY

1. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
2. Furnish and provide on-site educational seminars and schooling for the supplied BMS/DDC software package. The contractor shall provide for factory representatives to conduct the educational programming classes for the software package. The contractor shall provide and pay for expenses that are related to the educational programming classes. The contractor shall arrange the classes around the owner's representative's schedule.
3. Related Sections include the following:
  - a. Division 26 Section "Fire Alarm" for fire and smoke detectors mounted in HVAC systems and equipment.
  - b. Division 23 Section "Duct Accessories" for smoke dampers mounted in HVAC systems and equipment.
4. The work of this Section includes:
  - a. A complete system including power and control wiring of all control system components and devices.
  - b. Wiring circuits which are activated/de-activated by a control system component, such as but not limited to, EP/PE devices; high and low limit protective devices; solenoid air valves; relays; end switches; etc.

- c. Control panel wiring to control panels (unless noted otherwise) and to terminal strips; and field wiring from terminal strips to field mounted devices.
  - d. Wiring to the “auto” side of hand-off-auto switches on units being controlled by the Controls Contractor.
  - e. Wiring of all Electro-mechanical devices required to be located on or in temperature control panels.
  - f. Power and control wiring to all control system equipment including, but not limited to, control panels, motorized dampers and valve actuators, control transformers, VAV box actuators, time clocks, relays, transformers, PE switches, remote switches and all other control devices. Provide power wiring from electrical panel circuit breakers. Circuit breakers shall be provided under Division 23 and coordinated with Division 26 specification and submittals. Coordinate requirements with the Division 26 Contractor. Control equipment and devices that is provided with a voltage rating readily available at the location of installation. Coordinate with Contract Documents, submittals and Division 26 Contractor.
  - g. Wiring between components of packaged equipment (i.e., humidifier to air flow proving switch, etc.).
  - h. Provision and wiring of all remote manual control switches, including but not limited to, on/off switches, on/off switches with pilot lights, manual time switches, variable speed control switches.
  - i. Wiring of all smoke dampers including power wiring to damper; wiring between Fire Alarm System interface device and smoke dampers including all necessary control relays, contacts, and devices rated for voltages and amperages involved; wiring of smoke damper end switches for control sequencing. Coordinate with Division 26 “Fire Alarm”.
  - j. Interlock wiring from a Fire Alarm System interface device and/or duct mounted smoke detector relay contact to unit control circuit for system shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 “Fire Alarm”.
  - k. Interlock wiring from a Fire Alarm System interface device to unit control circuit for system emergency shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 “Fire Alarm”.
  - l. All interlocks to automatically shutdown and/or close HVAC equipment upon sensing a smoke condition and/or a fire alarm condition shall be hard wired and shall not be dependant upon software functions.
  - m. All line voltage wiring and conduit shall comply with the requirements of Division 26 Section “Wires and Cables”. All control wiring and cable shall comply with the requirements of Division 26 “HVAC Control Cable”. Licensed electricians shall perform all work in strict accordance with the NEC and other local codes.
  - n. Provide High Temperature Alarms on the existing refrigerators and freezers in the Kitchen/Cafeteria. Typical of 8 locations.
  - o. Implementation and check-out of Sequences of Operation.
5. Work by Others: The following work shall be performed by the associated division contractor under the supervision and coordination of this Subcontractor:
- a. Division 23 “Hydronic Piping” and “Steam and Condensate Piping” Contractor shall be responsible for:

- 1) Installation of all line size and non-line size automatic valves and separable wells furnished by the Contractor.
  - 2) Furnish and install all necessary valved pressure taps, steam, water and drain wells and everflow connections to piping.
  - 3) Furnish and install all necessary piping connections required for flow indicating devices.
- b. Division 23 “Metal Ductwork” Contractor shall be responsible for:
- 1) Install all control and smoke dampers and provide safing as required to install non-duct size dampers.
  - 2) Assemble multiple section dampers with required interconnecting linkages and extend the required number of shafts through the ducts for externally mounted damper motors.
  - 3) Provide and locate sheet metal baffle plates in ductwork, units, mixing boxes, plenums, etc., as required to eliminate stratification. Affix baffles permanently in place after stratification problem has been eliminated.
  - 4) Provide access doors or other approved means of access through ducts for service to control equipment.
  - 5) Mount air flow measuring stations and static pressure sensors in ductwork as directed by this Contractor.
  - 6) Mount isolation room air valves in ductwork as directed by this Contractor.
  - 7) Install all duct smoke detectors as furnished under Division 26.
- c. Division 23 “Mechanical” Contractor shall be responsible for:
- a) Furnishing and installing of circuit breakers (20A-1p) in panels for use by the ATCS Contractor to power the ATCS.
  - b) Furnishing and installing of required 24, 120, 277 volt power for BMS/DDC system controls and all equipment requiring electrical power to operate.
- d. Division 26 “Electrical” Contractor shall be responsible for:
- 1) Furnishing, installing and terminating all feeder and/or branch circuit wiring to major equipment including:
    - a) Wiring to and between all disconnects, starters, drives and equipment motors.
    - b) Furnishing duct smoke detectors specified under Division 26. The installation of the detectors shall be Division 23 “Metal Ductwork” and as supervised by this Contractor. The Division 26 Contractor shall furnish and install all wiring between the detector and the fire alarm system.

### 1.03 DEFINITIONS

1. DDC: Direct-digital controls.
2. LAN: Local area network.

3. MS/TP: Master-slave/token-passing.
4. PICS: Protocol Implementation Conformance Statement.

#### 1.04 SYSTEM DESCRIPTION

1. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, power and control wiring, and accessories to control mechanical systems.
2. The specification is not intended to detail each and every task required for full and compliance with the intent of this performance specification. Nor should a prospective bidder feel they are qualified to submit a bid price with out first becoming very familiar with the plans and specifications, existing automation system graphic display, remote access capabilities and equipment interoperability. The intent of this specification is to provide a control system utilizing TCP/IP protocol and BACnet as defined for the project and to allow all objects (objects as defined in the ANSI/ASHRAE standard 135-2001) to be fully interoperable and interfaced with the existing Central Monitoring and Control System located at the Vocational School's Middletown central office utilizing the existing wide area network, user files and graphics. The project's graphics and software must be programmed into the existing server and must utilize similar programming and graphic software as already exists. Control systems graphics shall look and operate consistently across all the school systems facilities. The existing DDC control system in Automated Logic.

#### 1.05 SUBMITTALS

1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase, for which the project is beginning, it will be returned not reviewed. This is a phased project and the BMS/DDC system product data is required to be submitted to the Engineer in a manner that reflects the phasing of the project.
2. Schematic flow diagrams showing fans, pumps, coils
  - a. Each control device labeled with setting or adjustable range of control.
3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. These shall be submitted incrementally and each phase of the project. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase the project is beginning it will be returned not reviewed. This is a phased project and the BMS/DDC system controls are required to be submitted to the Engineer in a manner that reflects the phasing of the project. The following shall be provided for each area under the present phase of construction for this project:



- a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - b. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - c. Details of control panel faces, including controls, instruments, and labeling.
  - d. Written description of sequence of operation.
  - e. Schedule of dampers including size, leakage, and flow characteristics.
  - f. Schedule of valves including leakage and flow characteristics.
  - g. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
  - h. Listing of connected data points, including connected control unit and input device.
  - i. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
  - j. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
4. ASHRAE BACnet Statement: PICS for each DDC system component (panel, zone controller, field devices, and operator workstation) proposed.
5. Samples: For each color required, of each type of thermostat cover.
6. Software and Firmware Operational Documentation: Include the following:
- a. Software operating and upgrade manuals.
  - b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - c. Device address list.
  - d. Printout of software application and graphic screens.
  - e. Software license required by and installed for DDC workstations and control systems.
7. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or monitoring and control revisions.
8. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
9. Maintenance Data: For systems to include in maintenance manuals specified in Division 1. Include the following:
- a. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
  - b. Interconnection wiring diagrams with identified and numbered system components and devices.
  - c. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  - d. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  - e. Calibration records and list of set points.

10. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
11. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

#### 1.06 QUALITY ASSURANCE

1. Installer Qualifications: An experienced installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
2. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance. The installers shall be BICSI certified commercial installer Technician level. Provide proof of current certification with submittal.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
5. Comply with ASHRAE 135 for DDC system control components.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

1. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

#### 1.08 COORDINATION

1. Coordinate and confirm location of thermostats, humidistats, and other exposed control sensors with Architect/Engineer and plans and room details before installation.
2. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system, including power/control voltage ratings and control sequence requirements.
3. Coordinate supply of conditioned electrical circuits for control units and operator workstation, including emergency power to all control components necessary to assure proper operation of HVAC equipment that is on the emergency power distribution system.
4. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
5. Coordinate equipment with Division 23 Sections "Enclosed Controllers" and "Variable Frequency Controllers" to achieve compatibility with controllers and annunciation devices.

6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

#### 1.09 EXTRA MATERIALS

1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
2. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat and positioning relay.
3. Maintenance Materials: One thermostat adjusting key.
4. Maintenance Materials: One pneumatic thermostat test kit.

### PART 2 - PRODUCTS

#### 2.01 VIDEO RECORDING

1. The contractor shall provide audio video recordings of training and operation for equipment provided to the project.
2. The recording quality shall be such that the audio is clearly distinguishable with zero background noise, and the video should have a studio quality.
3. A professional videographer shall do the recordings. The format shall be in standard Digital Versatile Disk, DVD.
4. The contractor shall provide audio video recordings of equipment maintenance, as described in 230923 2.0 B, C. The recordings shall include the equipment being maintained by qualified personnel, the required maintenance tools, and a step by step technique, both verbally and visually demonstrating how to maintain each piece of equipment in a hands on application.
5. The recordings shall include manufacturer's recommended maintenance items for each piece of equipment provided for the generator. The recordings shall also include but not limited to the following: greasing, oil changes, coolant changes, battery, environmental filters, air filters, fuel filters, battery charger, cleaning, block heater, oil pan heater, belts, hoses and items associated with equipment provided for the project.
6. The finished recordings shall be compiled into chapters. A binder shall be provided for each finished copy of the recordings. The binders shall be provided with a cover sheet, edge sheet, table of contents, disk holders and the description of each disk's recordings.
7. The contractor shall furnish four copies of the finished recordings. Three to be provided to the owner and one copy to the engineer for record.

2.02 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Electric, Electronic, Pneumatic, and DDC Systems:
    - a) Alerton Technologies, Inc.
    - 2) KMC Controls/Kreuter Manufacturing Company.
    - 3) Siebe Environmental Controls; Barber-Coleman/Robertshaw Products.
    - 4) Siemens Building Technologies, Inc.; Landis Division

2.03 DDC EQUIPMENT

1. Operator Station: Provide (2) Microcomputer stations with printers as specified in 2.2 B through 2.2 I.
2. Workstation: IBM-compatible microcomputer with minimum configuration as follows:
  - a. Processor: Intel Core 2 Duo 2.2 GHz or equivalent.
  - b. Random-Access Memory: 3.0 GB.
  - c. Graphics: Super video graphic adapter (SVGA), minimum 1280 x 1024 pixels, 8.0-MB video memory.
  - d. Monitor: 19 inches flat-panel lcd, wide screen, color, with maximum 0.28-mm dot pitch.
  - e. Keyboard: QWERTY, 105 keys in ergonomic shape.
  - f. Floppy-Disk Drives: 1.44 MB.
  - g. Hard-Disk Drive: 160.0 GB.
  - h. DVD/CD-ROM Drive: 16x (minimum)
  - i. Read-Write DVD/CD-ROM Drive: 16x (minimum)
  - j. Ports: (4) USB, (1) Serial, (1) parallel, and mouse ports.
  - k. Mouse: "Intellimouse" Two button with wheel.
  - l. Network Card: Linksys Ethernet 10/100 PCI card or equivalent
  - m. Operating System: Microsoft Windows XP-Professional or later.
  - n. BACnet Conformance: Workstation shall support BACnet device and have minimum capabilities defined in PICS for the following areas:
    - 1) Network.
    - 2) Functional groups.
    - 3) Standard application services supported.
    - 4) Standard objects supported.
3. Printer: Color, laser type as follows:
  - a. Print Head: 1440 x 1440 dpi photoquality color resolution (minimum).
  - b. Paper Handling: Minimum of 100 sheets.
  - c. Print Speed: Minimum of 8 ppm in black and 4 ppm in color.
4. Application Software: Include the following:
  - a. Input/output capability from operator station.
  - b. Operator system access levels via software password.
  - c. Database creation and support.
  - d. Dynamic color graphic displays.
  - e. Alarm processing.

- f. Event processing.
  - g. Automatic restart of field equipment on restoration of power.
  - h. Data collection.
  - i. Graphic development on workstation.
  - j. Maintenance management.
  - k. Microsoft Office Professional (Latest Version)
5. Graphics for the system shall include graphic floor plans of the project with overlaid area temperatures as well as system graphics for each air and water system which will show all components of the system with position and settings of system.
6. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
- a. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
  - b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - 1) Global communications.
    - 2) Discrete/digital, analog, and pulse input/output.
    - 3) Monitoring, controlling, or addressing data points.
    - 4) Testing and developing control algorithms without disrupting field hardware and controlled environment.
  - c. Local operator interface provides for download from or upload to mobile operator station.
  - d. BACnet Conformance: Reside on BACnet LAN in Ethernet IEEE 802.3, Class 3, minimum, with routers between LAN and other panels, with at least one communication port, and have minimum capabilities defined in PICS for the following areas:
    - 1) Network.
    - 2) Functional groups.
    - 3) Standard application services supported.
    - 4) Standard objects supported.
7. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
- a. Units monitor or control each input/output point; process information; and download from or upload to operator station.
  - b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - 1) Global communications.
    - 2) Discrete/digital, analog, and pulse input/output.
    - 3) Monitoring, controlling, or addressing data points.
  - c. Local operator interface provides for download from or upload to mobile operator station.
  - d. BACnet Conformance: Reside on BACnet LAN using MS/TP, Class 2, minimum, with at least one communication port, and have minimum capabilities defined in PICS for the following areas:

- 1) Network.
  - 2) Functional groups.
  - 3) Standard application services supported.
  - 4) Standard objects supported.
8. LANs: Capacity for a minimum of 10 workstations connected to multiuser, multitasking environment with concurrent capability to access DDC network or control units.
- a. Media: Ethernet, peer-to-peer CMA/CD, operating at 10 MBps.
  - b. Media: ARCNET (attached resources computer network), peer to peer, operating at 2.5 MBps.
9. Software: Update to latest version of software at Project completion. Include and implement the following capabilities from the control units:
- a. Units of Measure: Inch-pound and SI (metric).
  - b. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, DDC with fine tuning, and trend logging.
  - c. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
  - d. Chiller Control Programs: Control function of condenser water reset, chilled-water reset, and equipment sequencing.
  - e. Programming Application Features: Include trend point, alarm messages, weekly scheduling, and interlocking.

#### 2.04 CONTROL PANELS

1. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.
2. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
  - a. Fabricate panels of 0.06-inch- thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
  - b. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
  - c. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
  - d. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.
3. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.
  - a. Alarm Condition: Indicating light flashes and horn sounds.
  - b. Acknowledge Switch: Horn is silent and indicating light is steady.

- c. Second Alarm: Horn sounds and indicating light is steady.
- d. Alarm Condition Cleared: System is reset and indicating light is extinguished.
- e. Contacts in alarm panel allow remote monitoring by independent alarm company.

#### 2.05 ANALOG CONTROLLERS

- 1. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- 2. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
  - a. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
  - b. Proportional band shall extend from 2 to 20 percent for 5 psig.
  - c. Authority shall be 20 to 200 percent.
  - d. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal 0 to supply pressure.
  - e. Gauges: 1-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

#### 2.06 TIME CLOCKS

- 1. Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

#### 2.07 SENSORS

- 1. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
  - a. Thermistor or Resistance to Temperature (RTD) type temperature sensors as follows:
    - 1) Accuracy: Plus or minus 0.5 deg F at calibration point.
    - 2) Wire: Twisted, shielded-pair cable.
    - 3) Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
    - 4) Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
    - 5) Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
    - 6) Room Sensors: Provide with manufacturer's standard, locking cover and the following additional features:

- a) Set-Point Adjustment: Exposed.
- b) Set-Point Indication: Exposed.
- c) Thermometer: Exposed Digital display.
- d) Communications port.
- e) Occupancy override button, where sequence of operations calls for occupied/unoccupied control.
- f) Insulating Bases: For room temperature sensors located on exterior walls.
- g) Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base. Provide in public lobbies and corridors, and as indicated.
- h) Flush-mounted Sensors: As indicated.
- 7) Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- 8) Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- b. Humidity Sensors: Bulk polymer sensor element.
  - 1) Accuracy: 5 percent full range with linear output.
  - 2) Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
  - 3) Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
  - 1) Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - 2) Output: 4 to 20 mA.
  - 3) Building Static-Pressure Range: 0 to 0.25 inch wg.
  - 4) Duct Static-Pressure Range: 0 to 5 inches wg.
- d. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- e. Space and Duct Humidity Transmitters: One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3- to 15-psig output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.
  - 1) Space Mounting: With covers to match thermostats.
- f. Differential-Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig, and 3- to 15-psig output signal.
- g. Differential-Air-Pressure Transmitters: One pipe, direct acting, double bell, unidirectional with suitable range for expected input, and temperature compensated.
  - 1) Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
  - 2) Output Signal: 3 to 15 psig.
- 2. Equipment operation sensors as follows:
  - a. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- 3. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig.



4. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
5. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.
6. Refrigerant Detectors: Continuous sampling type infrared photo acoustic type capable of monitoring HFC-134a or HCFC-123 (to match chiller refrigerant) over a range of 0-1000 ppm with a sensitivity of 1 ppm. Unit features include:
  - a. 20 character LCD display and keypad to indicate gas concentrations, diagnostics and alarm conditions.
  - b. NEMA 4 enclosure.
  - c. Minimum of 2 relay contact outputs for warning and alarm level conditions.
  - d. Output signal of 4-20 mA, representing sampled gas concentration.
  - e. Audible alarm that sounds on alarm or trouble condition.
  - f. Unit shall be Mine Safety Appliances Company Chillgard RT or Yokogawa Model HGM200.
  - g. Install two (2) sampling tubes within the chiller room.
7. Carbon Monoxide, toxic, and combustible gas Sensors:
  - a. Sensors shall be a micro-processor-based system for continuous monitoring and use catalytic, electro-chemical, diffusion cell, or solid-state type sensing. Output shall be linearized 4-20 mA for use with 24 VDC input with green LED normal operation indicator. Unit shall provide a SPDT pilot duty low voltage alarm contact with an adjustable set point. The unit mounting shall be wall, duct aspiration, or ceiling to suit application. The unit shall specifically designed for the application and shall be explosion proof, as required. Unit shall have single point set point and span adjustment. The unit shall have no moving parts. Units mounted outdoors shall be waterproof and rustproof.
  - b. Minimum requirements:  
Range: as required for application; ppm, %, %L.E.L.  
Accuracy: 3-5% of full scale  
Repeatability: 1% of full scale  
Power Consumption: 5 watts or less  
Relay contact rating: 5 amp at 24 VDC, 150 VA max. inductive  
Zero Drift at Constant Temp.: 0 per 24 hrs (random not cumulative)  
Max. allowable Drift in 1 year: 1% of full scale
  - c. Approved Manufacturers:  
Draegar  
Vulcain

## 2.08 THERMOSTATS

1. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

2. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
  - a. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
  - b. Dead Band: Maximum 2 deg F.
3. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
  - a. Bulbs in water lines with separate wells of same material as bulb.
  - b. Bulbs in air ducts with flanges and shields.
  - c. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
  - d. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
  - e. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
  - f. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
4. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Concealed.
  - b. Set-Point Indication: Concealed.
  - c. Thermometer: Concealed
5. Room thermostat accessories include the following:
  - a. Insulating Bases: For thermostats located on exterior walls.
  - b. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
  - c. Adjusting Key: As required for calibration and cover screws.
  - d. Aspirating Boxes: For flush-mounted aspirating thermostats.
  - e. Set-Point Adjustment: 1/2-inch- diameter, adjustment knob.
6. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
7. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
8. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
  - a. Bulb Length: Minimum 20 feet.
  - b. Quantity: One thermostat for every 20 sq. ft. of coil surface.

9. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
  - a. Bulb Length: Minimum 20 feet.
  - b. Quantity: One thermostat for every 20 sq. ft. of coil surface.
10. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

## 2.09 HUMIDISTATS

1. Pneumatic Room Humidistats: Wall-mounted, proportioning type with adjustable throttling range, 25 to 65 percent operating range, cover matching room thermostat cover.
2. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable 2 percent throttling range, 20 to 80 percent operating range, single- or double-pole contacts.

## 2.10 ACTUATORS

1. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - a. Comply with requirements in Division 23 Section "Motors."
  - b. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
  - c. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  - d. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
  - e. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  - f. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
2. Electronic Damper and Large-Valve Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
  - a. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
  - b. Dampers: Size for running torque calculated as follows:
    - 1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
    - 2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
    - 3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. of damper.
    - 4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.

- 5) Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
- 6) Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2500 to 3000 FPM: Multiply the minimum full-stroke cycles above by 2.0.
- c. Coupling: V-bolt and V-shaped, toothed cradle.
- d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- e. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
- f. Power Requirements (Two-Position Spring Return): 24 or 120-V ac.
- g. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
- h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
- i. Temperature Rating: Minus 22 to plus 122 deg F.
- j. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
- k. Run Time: 60 seconds.

#### 2.11 CONTROL VALVES

- 1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Contractor shall size all control valves for flows and system operating conditions, achieving operation in mid-range of valve stroke.
- 2. Globe Valves NPS 2 and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
- 3. Globe Valves NPS 2-1/2 and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
- 4. Hydronic system globe valves shall have the following characteristics:
  - a. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
  - b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
    - 1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    - 2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
  - c. Sizing: 3-psig maximum pressure drop at design flow rate.
  - d. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
- 5. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
  - a. Body Style: Lug.
  - b. Disc Type: Aluminum bronze.
  - c. Sizing: 1-psig maximum pressure drop at design flow rate.

6. Terminal Unit Control Valves: Bronze body, bronze trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.
  - a. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
  - b. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
  - c. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

## 2.12 DAMPERS

1. Dampers: AMCA-rated, parallel-blade design; 0.1084-inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch galvanized steel with maximum blade width of 8 inches.
  - a. Blades shall be secured to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
  - b. Operating Temperature Range: From minus 40 to plus 200 deg F.
  - c. For standard applications, include optional closed-cell neoprene edging.
  - d. All dampers shall be low-leakage parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.
  - e. Provide parallel blade design for two-position applications, and opposed-blade design for modulating applications.

## 2.13 AIRFLOW MONITORING STATIONS

1. Fan inlet airflow monitoring stations shall be VOLU-Probe/FI as manufactured by Air Monitor Corporation, or equal by Brandt, and shall be capable of continuously measuring the air handling capacity of the respective centrifugal fan. Provide three per AHU/RTU.
  - a. The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
  - b. The fan inlet airflow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal take-offs and fittings, and shall be of aluminum construction with hard anodized finish.
  - c. The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level within the system be amplified by its presence in the fan inlet bell. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections of factors,

with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.

2. Duct airflow monitoring stations shall be mounted where shown on the Drawings, Fan-E as manufactured by Air Monitor Corporation, or equal by Brandt, and shall be capable of continuously measuring the airflow of their respective duct system.
  - a. Each airflow measuring station shall contain multiple total and static pressure sensors position at the center of equal area of the station cross-section and interconnected by their respective averaging manifolds. For station of 4 square feet or less, one total and one static pressure sensor shall be present for every 16 square inches of station area respectively. For station of larger area, one total and one static pressure sensor shall be present for every 36 square inches of station area respectively.
  - b. The airflow monitoring stations shall be fabricated on a minimum of 14 gauge galvanized steel, welded casing in an 8 inch depth with 90° connecting flanges, fabricated to the duct size. Each station shall be complete with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to the casing, total and static pressure sensors located on an equal area basis and connected to symmetrical averaging manifolds, internal piping, and external pressure transmitter ports. An identification label shall be placed on each station casing listing model number, size area, and specified airflow capacity.
  - c. The maximum allowable pressure loss through the station shall not exceed 0.015" WC at 1000 fpm, or 0.085" WC at 2000 fpm. Each station shall be capable of measuring the airflow rate within an accuracy of 2 percent as determined by USGSA certification tests. The stations shall have self-generated sound rating of less than NC 40, and the sound level within the duct shall not be amplified, nor shall addition sound be generated.
3. Airflow transmitters shall be Air Monitor Corporation Veltron II, or equal by Brandt, capable of receiving flow signals from an airflow station or probe array and produce dual outputs linear and scaled for air volume, velocity, differential pressure, etc. The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. The transmitter shall be available in multiple natural spans covering the range of 0.01" W.C. to 2.0" W.C. with an accuracy of  $\pm 0.25\%$  of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity (100 to 1 pressure) turndown.

#### 2.14 CONTROL CABLE

1. Electronic and Fiber-Optic Cable for Control Wiring: As specified in Division 26 Section "HVAC Control Cabling."

#### 2.15 SUMMARY OF INPUT/OUTPUT POINTS

1. The points listed below are a minimum quantity of points required for the DDC system to operate properly. Provide all points required, whether indicated below, on the Flow and Control Diagrams, or as required to implement the specified sequences of operation.

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<b>SYSTEM: CHILLED WATER</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
CH-1	CHILLER	S	S/S	KW, T	
CH-2	CHILLER	S	S/S	KW, T	
	CHW SUPPLY			T	
	CHW RETURN			T	
P-3	CHILLED WATER PUMP	S	S/S	P	C
P-4	CHILLED WATER PUMP	S	S/S	P	C
CHILLERS	MINIMUM FLOW VALVE V-7			P	C
CHILLERS	THREE WAY VALVE V-6			P	C
CHILLERS	PLATE-FRAME HX BYPASS	P	O/C		

<b>SYSTEM: HOT WATER</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
HWB-#	BOILER CONTROL PANEL	MOD	MOD	MOD	MOD
HWB-1	HOT WATER BOILER #1	S			
HWB-2	HOT WATER BOILER #1	S			
HWB-3	HOT WATER BOILER #1	S			
HWB-4	HOT WATER BOILER #1	S			
P-1	HOT WATER PUMP	S	S/S	P	C
P-2	HOT WATER PUMP	S	S/S	P	C
P-7	HOT WATER PUMP	S	S/S	P	C
P-8	HOT WATER PUMP	S	S/S	P	C
P-9	HOT WATER PUMP	S			
P-10	HOT WATER PUMP	S			
P-11	HOT WATER PUMP	S			
P-12	HOT WATER PUMP	S			
	HW SUPPLY			T	
	HW RETURN			T	
	GHW SUPPLY			T	
	GHW RETURN			T	
	GHW LOOP			T	
	HW DIFF. PRESS			DP	
	GHW DIFF. PRESS			DP	
	PFHX GLYCOL VALVE V-1			P	C
	PFHX GLYCOL VALVE V-2			P	C

<b>SYSTEM: CONDENSER WATER</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
P-5	CW PUMP	S	S/S	P	C
P-6	CW PUMP	S	S/S	P	C
CH-1	ISOLATION VALVE			O/C	
CH-2	ISOLATION VALVE			O/C	
	CW SUPPLY			TEMP	
	CW RETURN			TEMP	
CT-1	FAN	DP	S/S	P	C
CT-1	TYP ISOLATION VALVE	P	O/C		
CT-2	FAN	DP	S/S	P	C
CT-2	TYP ISOLATION VALVE	P	O/C		
CT-1	BASIN BYPASS VALVE			P	C
CT-2	BASIN ISOLATION VALVE			P	C
TOWERS	BYPASS VALVE V-1			P	C
TOWERS	FILTRATION	S			
TOWERS	EQUALIZER LINE	P	O/C		

<b>SYSTEM: TYPICAL AIR HANDLING SYSTEMS</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
AC-#	SUPPLY FAN	S	S/S	P	C
AC-#	RETURN AIR			T	
AC-#	RETURN AIR			CFM	
AC-#	RETURN AIR			H, CO2	
AC-#	MIXED AIR			T	
AC-#	CHILLED WATER COIL VA.				C
AC-#	GLYCOL HEATING COIL VALVE				C
AC-#	FILTER			DP	
AC-#	SUPPLY AIR			T	
AC-#	SUPPLY AIR			DP	
AC-#	SUPPLY AIR			H	
AC-#	OUTSIDE AIR			CFM	
AC-#	O.A. DAMPER				C
AC-#	SUPPLY AIR DAMPER		O/C		
AC-#	RETURN AIR DAMPER		O/C		
AC-#	TYPICAL ERU BYPASS DAMPER				C
AC-#	ECONOMIZER DAMPER (OA)				C
AC-#	ECONOMIZER DAMPER (RA)				C



AC-#	EXHAUST AIR DAMPER					C
AC-#	RELIEF FAN	DP	S/S	P		C
AC-#	RELIEF FAN			CFM		
AC-#	RELIEF AIR			T,H		
TYP VAV BOX	ZONE SPACE			T, CO2		
TYP VAV BOX	VAV DAMPER			P		C
TYP VAV BOX	INLET			CFM		
TYP VAV BOX	DISCHARGE			T		
TYP VAV BOX	HW CONTROL VALVE					C
TYP VAV BOX	RAD. CONTROL VALVE					C

(PROVIDE VAV DAMPER CONTROL AND RADIATION CONTROL VALVE CONTROL ON A PER-ZONE BASIS)

**SYSTEM: TYPICAL HEATING AND VENTILATING SYSTEM**

<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
HV-#	SUPPLY FAN	S	S/S	P	C
HV-#	RETURN AIR			T	
HV-#	RETURN AIR			CFM	
HV-#	RETURN AIR			H, CO2	
HV-#	MIXED AIR			T	
HV-#	GLYCOL HEATING COIL VALVE				C
HV-#	FILTER			DP	
HV-#	SUPPLY AIR			T	
HV-#	SUPPLY AIR			DP	
HV-#	SUPPLY AIR			H	
HV-#	OUTSIDE AIR			CFM	
HV-#	O.A. DAMPER				C
HV-#	SUPPLY AIR DAMPER		O/C		
HV-#	RETURN AIR DAMPER		O/C		
HV-#	TYPICAL ERU BYPASS DAMPER				C
HV-#	RELIEF AIR DAMPER				C
HV-#	RELIEF FAN	DP	S/S	P	C
HV-#	RELIEF FAN			CFM	
HV-#	RELIEF AIR			T,H	
HV-1	SPACE (2 CASES)			CO	
TYP VAV BOX	ZONE SPACE			T, CO2	
TYP VAV BOX	VAV DAMPER			P	C
TYP VAV BOX	INLET			CFM	

TYP VAV DISCHARGE T  
 BOX  
 TYP VAV HW CONTROL VALVE C  
 BOX  
 TYP VAV RAD. CONTROL VALVE C  
 BOX  
 (PROVIDE VAV DAMPER CONTROL AND RADIATION CONTROL  
 VALVE CONTROL ON A PER-ZONE BASIS)

**SYSTEM: MAKEUP AIR UNIT**

UNIT	DESCRIPTION	DI	DO	AI	AO
MUA	SUPPLY FAN	S	S/S		
	OA DMPR		O/C		
	FILTER			DP	
	EXHAUST FAN	S	S/S		

**SYSTEM: AUTO TAILPIPE EXHAUST**

UNIT	DESCRIPTION	DI	DO	AI	AO
	EXHAUST FAN	S	S/S	P	C
	OA DMPR		O/C		
	TYPICAL SWITCH (ONE PER HOSE REEL)	ON/OFF			

**SYSTEM: WELDING EXHAUST**

UNIT	DESCRIPTION	DI	DO	AI	AO
EXH	EXHAUST FAN	S	S/S	P	C
	OA DMPR		O/C		
	TYPICAL SWITCH	ON/OFF			

**SYSTEM: GAS FIRED UNIT HEATERS**

UNIT	DESCRIPTION	DI	DO	AI	AO
EXH	SPACE			T	
	UNIT HEATER CONTROL PANEL		S/S		

**SYSTEM: ELECTRIC FIRED UNIT HEATERS**

UNIT	DESCRIPTION	DI	DO	AI	AO
EXH	SPACE			T	
	UNIT HEATER CONTROL PANEL		S/S		

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<b>SYSTEM: DOOR AIR CURTAINS</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
EXH	LOCAL SWITCH	ON/OFF			
	CONTROL PANEL		S/S		
	GLYCOL HW CONTROL VALVE				C
 <b>SYSTEM: MISCELLANEOUS</b>					
<b>UNIT</b>	<b>DESCRIPTION</b>	<b>DI</b>	<b>DO</b>	<b>AI</b>	<b>AO</b>
	EXHAUST FAN	S	S/S		
	FIRE ALARM	A	LIGHTING		
	SECURITY	A	LIGHTING		
	GENERATOR	A	LOAD SHED		
	LIGHTING	S*	ON/OFF**		
	SEWAGE EJECTOR	HI			
		WATER			
		ALARM			
	SEWAGE EJECTOR	LAG			
		PUMP			
		RUN			
	SUMP PUMP	HI			
		WATER			
		ALARM			
	SUMP PUMP	LAG			
		PUMP			
		RUN			
	OUTSIDE AIR (COMMON FOR AHU'S AND H& V UNITS)			T, H	
	BREAKGLASS	ON/OFF			
	FUEL OIL PUMP SET	S	S/S		
	Heat tracing	ON/OFF	C	T-outdoor	Precipitation
* -	Multiple inputs from photocells, switches, fire alarm system, security system or other devices. Coordinate with Security, telecommunication and Division 26 for requirements and quantities.				
** -	Multiple outputs - Coordinate with Division 26 for requirements and quantities.				
Abbreviations:	A – ALARM				
	C – CONTROL				
	CFM - MEASURED AIRFLOW				
	CO2 – MEASURED CARBON DIOXIDE				
	CO – MEASURED CARBON MONOXIDE				
	DP - DIFFERENTIAL PRESSURE				
	H - RELATIVE HUMIDITY				
	L – LIGHTING				

LT - LOW TEMPERATURE  
O/C - OPEN/CLOSE  
P – POSITION  
S – STATUS  
S/S - START/STOP  
T – TEMPERATURE  
MOD – MODBUS CONNECTION

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

1. Verify that conditioned power supply is available to control units and operator workstation.
2. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

#### 3.02 INSTALLATION

1. Install equipment level and plumb.
2. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
3. Connect and configure equipment and software to achieve sequence of operation specified.
4. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.
  - a. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
5. Install guards on thermostats in the following locations:
  - a. Entrances.
  - b. Public areas.
  - c. Where indicated.
6. Install automatic dampers according to Division 23 Section "Duct Accessories."
7. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
8. Install labels and nameplates to identify control components according to Division 23 Section "Basic Mechanical Materials and Methods."

9. Install labels and nameplates to identify control components according to Division 23 Section "Mechanical Identification."
10. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
11. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
12. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
13. Install electronic and fiber-optic cables according to Division 26 Section "HVAC Control Cabling."
14. Provide High Temperature Alarms on the existing refrigerators and freezers in the Kitchen/Cafeteria. Typical of 8 locations.

### 3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

1. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."
2. Install building wire and cable according to Division 26 Section "Conductors and Cables."
3. Install signal and communication cable according to Division 26 "HVAC Control Cabling."
4. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
5. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.04 CONNECTIONS

1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
  - a. Install piping adjacent to machine to allow service and maintenance.
2. Ground equipment.
  - a. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  - a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - b. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
  - c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
  - d. Calibration test electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
2. Engage a factory-authorized service representative to perform startup service.
3. Replace damaged or malfunctioning controls and equipment.
  - a. Start, test, and adjust control systems.
  - b. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
  - c. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
4. Verify DDC as follows:
  - a. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
  - b. Verify operation of operator workstation.
  - c. Verify local control units including self-diagnostics.

3.06 DEMONSTRATION

1. Refer to Specification 230923 2.0 for videotaping requirements.
2. Furnish and provide educational seminars and schooling for the provided BMS/DDC software package.
3. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
  - a. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
  - b. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of (3) non-coincidental 32 hour weeks for dedicated instructor time on-site. Training sessions shall be video taped and three (3) copies given to the owner.
  - c. Refer to 1.2 B of this specification section for additional information.
  - d. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

- e. Schedule training with Owner, through Architect, with at least seven days' advance notice.

### 3.07 ON-SITE ASSISTANCE

1. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

### 3.08 SEQUENCE OF OPERATION – BOILER SYSTEM

1. Existing boiler B-2 shall remain and operate according to its existing controls, until it is removed. All existing controls on the boiler shall be maintained in operating condition during this time.
2. Existing boiler B-1 and all associated controls shall be removed to allow the installation of the hot water boilers.
3. Hot water boilers HWB-1 through HWB-4 shall be controlled via the boiler room system administrator, which shall control the operation of the boilers and the associated inline pumps P-9 through P-12, as well as the combustion air dampers.
4. Boiler controller shall be capable of remote enable and remote set point override via external Modbus write commands. Any communication failure shall cause the controller to remain operating and revert to its normally calculated reset schedule.
5. The boiler room system administrator shall signal the DDC system with two levels of boiler control system alarm: low building temperature alarm triggered by low supply temperature set point and a general alarm indicating boiler and/or pump alarms and/or unavailability of boilers and/or pumps.
6. Individual boiler status (on/off) shall be reported to the DDC system.
7. The DDC system shall command the boilers on in "Heating" mode, and off in "Cooling" mode.

### 3.09 SEQUENCE OF OPERATION – HOT WATER

1. If the DDC system is in the "Heating" mode, the lead hot water pump (P-1 or P-2) shall be started automatically by the DDC system and shall run continuously. The "lead" hot water pump shall be rotated on a weekly basis to equalize run time.
2. The 1/3 and 2/3 glycol hot water control valves serving the plate frame heat exchanger shall be controlled in sequence in response to load.

3. The hot water supply temperature shall be controlled inversely in proportion to outdoor air temperature as indicated below:

Outdoor Temp	Hot water supply temp
0°F	125°F
30°F	115°F
60°F	110°F
4. Hot water pump speed shall be controlled from the system differential pressure controller.
5. In the event of a hot water pump failure, the "lag" pump shall start automatically and an alarm shall sound at the DDC system.

**3.10 SEQUENCE OF OPERATION – GLYCOL HOT WATER**

1. If the DDC system is in the “Heating” mode, the lead glycol hot water pump (P-7 or P-8) shall be started automatically by the DDC system and shall run continuously. The "lead" hot water pump shall be rotated on a weekly basis to equalize run time.
2. The glycol hot water supply temperature shall be controlled inversely in proportion to outdoor air temperature as indicated below:

Outdoor Temp	Hot water supply temp
0°F	160°F
30°F	145°F
60°F	130°F
3. Hot water pump speed shall be controlled from the system differential pressure controller.
4. In the event of a hot water pump failure, the "lag" pump shall start automatically and an alarm shall sound at the DDC system.

**3.11 SEQUENCE OF OPERATION – CHILLED WATER SYSTEM**

1. If the DDC system is in the “Cooling” mode, the lead chilled water pump shall be started automatically by the DDC system and shall operate continuously. Auxiliary cooling mode shall be construed as any time during the “Heating” mode when chilled water is required to supplement the air-side economizer mode of the air handling units, or when needed for supplementary cooling for point heating loads (e.g., fan coil units and computer room cooling units).
2. The "lead" chiller and chilled water pump shall be rotated on a weekly basis to equalize pump run time. Chillers shall be capable of being assigned lead and lag separately from the chilled water pumps, condenser water pumps and cooling towers.
3. Once enabled, the lead chilled water pump and condenser water pump are running and flow through the chiller has been proven, the lead chiller shall be permitted to start through its integral control system. A manual reset shall be required upon loss of chilled water flow.



4. If the lead chiller is operating at full capacity, and the chilled water supply temperature rises above setpoint, the lag chiller shall be enabled. Once enabled, the lag chilled water pump and lag condenser water pump are running and flow through the lag chiller has been proven, the lag chiller shall be permitted to start through its integral control system. A manual reset shall be required upon loss of chilled water flow.
5. If the chilled water supply temperature drops, the lead and lag chillers shall modulate in unison to 50% of their output. Upon a further drop in chilled water supply temperature, the lag chiller shall be de-energized.
6. Chilled water pump speed shall be controlled from the system differential pressure controller. The chiller manufacturer shall provide the DDC contractor with the minimum chilled water flow through the chiller. The two-way chilled water bypass shall modulate to maintain this minimum flow through the chiller.
7. When the lead chiller is at minimum flow and minimum output, and the chilled water temperature continues to drop, the three-way valve shall modulate to maintain chilled water supply temperature setting. The chilled water pumps shall increase flow to maintain minimum flow through the chiller and to maintain setpoint temperature, via mixing of the bypass flow.
8. A separate immersion thermostat in the chilled water supply line will start and control the operation of chiller.
9. A separate low limit thermostat in the chilled water supply will override the controlling thermostats to maintain chilled water temperature within safety limits.
10. The thermostats and relays will control the unloaders and/or cycle the compressors in the chiller units to maintain constant temperature of chilled water supply.
11. The chiller safety devices will shut down the units when they sense unsafe conditions, and activate an audible and visual alarm.
12. Differential pressure controllers in the chilled water circuit will permit the refrigeration compressors to operate only when flow is indicated through the chiller. A manual reset shall be required upon loss of chilled water flow.

### 3.12 SEQUENCE OF OPERATION – CONDENSER WATER SYSTEM

1. The lead condenser water pump shall be started automatically by the DDC system and shall operate continuously. The "lead" condenser water pump shall be rotated on a weekly basis to equalize pump run time.
2. The lead cooling tower shall be started automatically by the DDC system and shall operate continuously. The "lead" cooling tower shall be rotated on a weekly basis to equalize tower run time.

3. The lead condenser water pump and lead chiller shall be matched to the lead chiller. The operator shall have the option to select either condenser water pump and either cooling tower as the "lead" equipment.
4. Differential pressure controllers in the condenser water circuit will permit the chiller(s) to operate only when flow is indicated through the condenser.
5. Each cooling tower's fans shall not start until the respective isolation dampers and isolation valves are open.
6. The speed of the lead and lag cooling tower fans shall be controlled in response to condenser water supply temperature. When the chillers are in operation, the condenser water set point temperature shall be 85°F. At 85°F, both cooling tower's fans shall operate at 100% speed. At 80°F condenser water supply temperature, both cooling tower's fans shall operate at 25% speed. At 75°F, the lag cooling tower fan shall be de-energized. Below 72°F, both cooling tower's fans shall be off. Below 45°F, the lead tower basin bypass valve (V-4 or V-5) shall open and the lead tower supply valve (V-2 or V-3) shall close. When only one tower is operating, the equalizing line isolation valve shall close.
7. The chiller condenser water bypass valve V-1 shall modulate to maintain the condenser water supply temperature to the chiller at a minimum of 70oF.

3.13 SEQUENCE OF OPERATION, ROOFTOP GLYCOL HEAT/CHILLED WATER COOL UNITS

1. The system shall be started and stopped from the DDCP, in accordance with the DDCP's operating schedule.
2. The system combination fire and smoke detectors shall shutdown the supply fan and sound both a local and remote alarm through the fire alarm system provided under division 26.
3. Outside air intake dampers and exhaust dampers shall close whenever the supply fan is not running.
4. A discharge thermostat shall modulate the chilled water control valve to maintain a constant discharge temperature of 55oF (adjustable) in cooling mode, and modulate the glycol control valves to maintain a constant discharge temperature of 68oF (adjustable) in heating mode.
5. During summer months, the space temperature setpoint shall be 76oF (adjustable). During winter months, the space temperature setpoint shall be 68oF (adjustable).
6. A manually reset freeze protection thermostat, set at 40oF (adjustable) shall cause the supply fan to stop and outside dampers to close.
7. Outside air quantities shall be modulated based on the measured carbon dioxide (CO<sub>2</sub>) levels in the return air of each unit. Outside air usage shall be minimized, and shall be increased to maintain a maximum CO<sub>2</sub> level of 1,500 PPM (adjustable).

8. The outside dampers shall close if return air temperatures drop below 65oF (adjustable).
9. The air handling unit shall include enthalpy wheel-type energy recovery sections (ERU). The DDC system shall modulate the return air dampers and exhaust fan capacity to match the system outside air rate, and shall energize the energy recovery wheel during operation of the unit to maximize the energy reclaim. The DDC system shall stop/jog the ERU wheel during cold periods as required to prevent icing of latent moisture in the wheel. The DDC system shall stop the ERU wheel and open the ERU bypass dampers when the system is in economizer operation, or when not needed for energy reclaim.
10. Morning warm-up: An hour before normal occupancy schedule through DDC system, system shall start under normal start sequence except outside air damper and spill damper shall remain closed and all system VAV boxes shall go full open. Chilled water control valves and glycol control valves shall be sequenced until return duct temperature rises above space setpoint. When setpoint is achieved the system through the DDC shall switch to normal occupied mode.

#### 3.14 SEQUENCE OF OPERATION, ROOFTOP HEATING AND VENTILATING UNITS

1. The system shall be started and stopped from the DDCP, in accordance with the DDCP's operating schedule.
2. The system combination fire and smoke detectors shall shutdown the supply fan and sound both a local and remote alarm through the fire alarm system provided under division 26.
3. Outside air intake dampers and exhaust dampers shall close whenever the supply fan is not running.
4. A discharge thermostat shall modulate the glycol control valve to maintain a constant discharge temperature of 80oF (adjustable) in heating mode. The glycol control valve shall be closed during cooling mode.
5. During summer months, the space temperature setpoint shall be uncontrolled. During winter months, the space temperature setpoint shall be 68oF (adjustable).
6. A manually reset freeze protection thermostat, set at 40oF (adjustable) shall cause the supply fan to stop and outside dampers to close.
7. Outside air quantities shall be modulated based on the measured carbon dioxide (CO<sub>2</sub>) levels in the return air of each unit. Outside air usage shall be minimized, and shall be increased to maintain a maximum CO<sub>2</sub> level of 1,500 PPM (adjustable).
8. The outside dampers shall close if return air temperatures drop below 65oF (adjustable).
9. All air handling units except AC-14 shall include enthalpy wheel-type energy recovery sections (ERU). The DDC system shall modulate the return air dampers and exhaust fan capacity to match the system outside air rate, and shall energize the ERU energy recovery wheel during operation of the unit to maximize the energy reclaim. The DDC system

shall stop/jog the ERU wheel during cold periods as required to prevent icing of latent moisture in the wheel. The DDC system shall stop the ERU wheel and open the ERU bypass dampers when the system is in economizer operation, or when not needed for energy reclaim.

10. Air handling unit AC-14 shall include a flat plate heat recovery system. The DDC system shall modulate the return air dampers and exhaust fan capacity to match the system outside air rate, and shall maximize the energy reclaim. The DDC system shall open the ERU bypass dampers when the system is in economizer operation, or when not needed for energy reclaim.
11. Morning warm-up: An hour before normal occupancy schedule through DDC system, system shall start under normal start sequence except outside air damper and spill damper shall remain closed and all system vav boxes shall go full open. Glycol control valve shall be modulated until return duct temperature rises above space setpoint. When setpoint is achieved the system through the DDC shall switch to normal occupied mode.
12. For HV-1, either of the space mounted carbon monoxide sensors shall modulate the outside air and exhaust air dampers open, and introduce outside air in rates sufficient to limit the carbon monoxide in the space to under 25 PPM (adjustable), as sensed by the space CO sensor.

### 3.15 SEQUENCE OF OPERATION - UNIT HEATERS AND CABINET HEATERS

1. An electric space thermostat shall cycle the unit fan when it falls below its set point.
2. Cabinet heater fan speed shall be manually selected at the unit.

### 3.16 SEQUENCE OF OPERATION - RADIATION

1. A reverse acting aquastat shall open the isolation valve when required only if the system water temperature is above 100oF.
2. For all spaces, the electric space temperature sensor shall cycle the radiation control valve to maintain its setpoint (adjustable), through the DDCP.

### 3.17 SEQUENCE OF OPERATION - KITCHEN EXHAUST FAN AND MAKEUP AIR UNIT

1. The kitchen exhaust fan and makeup air unit shall be started from a local start/stop switch (with pilot light) at the hood through the DDC system. The DDCP shall monitor the operation of these units.
2. The DDC system shall start and stop the supply fan, and open and close the motorized damper. In addition, the unit's integral control system shall modulate the gas control valve to maintain a constant leaving air temperature during heating mode.
3. Kitchen exhaust fan shall be interlocked to the hood fire extinguishing system to shut down in event of fire. Refer to separate specification section for the hood extinguishing system.

3.18 SEQUENCE OF OPERATION - DISHWASHER EXHAUST SYSTEM

1. Dishwasher exhaust system shall be started and stopped from a local start/stop switch (with pilot light), once enabled through the DDC system. The local switch shall be wall mounted adjacent to the dishwasher.
2. The motorized backdraft damper shall be interlocked to open when the fan runs.
3. The DDC system, in accordance with the system's operating schedule, shall enable the fan to start, and shall stop the fan if the adjustable time interval of the operating schedule has elapsed.

3.19 SEQUENCE OF OPERATION - KILN HOOD EXHAUST FAN

1. The kiln hood exhaust fan shall be started and stopped from a local start/stop switch (with pilot light), once enabled through the DDC system. The local switch shall be wall mounted adjacent to the kiln.
2. The motorized backdraft damper shall be interlocked to open when the fan runs.
3. The DDC system, in accordance with the system's operating schedule, shall enable the fan to start, and shall stop the fan if the adjustable time interval of the operating schedule has elapsed.

3.20 SEQUENCE OF OPERATION – CHILLER ROOM EXHAUST

1. A wall mounted space sensor shall open the fan inlet damper, and the make up air damper in the Generator Room. The fan shall start after a time delay (adjustable).
2. A signal from the refrigerant monitoring panel shall override the space sensor, open the intake and make up air dampers, and start the fan, if the fan is indexed off. Receipt of a signal from the refrigerant monitoring panel shall cause an alarm to be registered with the DDC system.
3. Local breakglass station shall de-energize chiller, energize exhaust fan start sequence and generate an alarm at the DDCP.
4. The motorized backdraft damper and makeup air dampers shall be interlocked to open when the fan runs.

3.21 SEQUENCE OF OPERATION - TOILET EXHAUST SYSTEMS

1. Central exhaust systems shall be started and stopped from the DDCP, in accordance with the DDCP's operating schedule.
2. Single exhaust systems shall be interlocked with the light switch for the toilets that they serve.

3. The motorized backdraft damper shall be interlocked to open when the fan runs.

3.22 SEQUENCE OF OPERATION – ELECTRICAL ROOM EXHAUST SYSTEMS

1. The space temperature sensor shall energize the fan on a rise in temperature.
2. Operation of the fan shall be reported to the DDCP.
3. The motorized dampers shall be interlocked to open when the fan is energized.

3.23 SEQUENCE OF OPERATION – GENERAL EXHAUST SYSTEMS

1. Where not specifically specified to the contrary, exhaust fans shall be started and stopped by wall mounted switches, with pilot lights.
2. Operation of the fan shall be reported to the DDCP.
3. The motorized dampers shall be interlocked to open when the fan is energized.

3.24 SEQUENCE OF OPERATION – COMPRESSOR MAKEUP AIR

1. The operation of central shop compressors shall be monitored by the DDC system.
2. The motorized backdraft damper shall be interlocked to open when either or the compressors runs

3.25 SEQUENCE OF OPERATION – CARPENTRY SHOP DUST COLLECTION SYSTEM

1. The dust collector shall be started through the DDCP whenever any equipment connected to it is started, as sensed by a current sensing device attached to the power feeder to the equipment.
2. At each floor sweep, a manual switch with pilot light shall also start and stop the dust collector through the DDCP.
3. The dust collector shall continue to run for 5 minutes (adjustable) after all the associated woodworking equipment has been shut down, and the manual switches are in the off position.
4. A red blinking visual indicator shall be located on the wall of the Carpentry shop, which will indicate when the dust collector hopper is  $\frac{3}{4}$  full.

3.26 SEQUENCE OF OPERATION – WELDING HOOD EXHAUST SYSTEMS

1. Welding area exhaust fans shall be provided with a local manual switch, with pilot light, that shall energize and de-energize the respective exhaust fan through the DDCP.
2. When the exhaust fan is de-energized, it shall continue to run for an additional 5 minutes (adjustable).

3. The motorized backdraft damper shall be interlocked to open when the fan runs.
4. When only one of the two welding station switches is in the on position, the VFD on the associated makeup air unit shall modulate the fan to produce 50% of the unit capacity. When both of the two welding station switches are in the on position, the VFD on the associated makeup air unit shall modulate the fan to produce 100% of the unit capacity..

3.27 SEQUENCE OF OPERATION –SHOP GENERAL EXHAUST SYSTEMS

1. Shop general exhaust fans shall be provided with a local manual switch, with pilot light, that shall energize and de-energize the respective exhaust fan through the DDCP. The manual switch shall be a three-position switch, capable of providing OFF-LOW-HIGH operation of the fan.
2. When the exhaust fan is de-energized, it shall continue to run for an additional 5 minutes (adjustable).
3. The motorized backdraft damper shall be interlocked to open when the fan runs.
4. When in the high position, a local buzzer and red flashing light shall be energized to alert the staff and/or students to open a door to the outside. The buzzer and light shall have a 10-second (adjustable) duration.

3.28 SEQUENCE OF OPERATION – FUME HOOD EXHAUST SYSTEMS

1. Fume hood exhaust fans shall be started manually through a switch at the fume hood, and shall run for an adjustable time after turned off at the switch at the fume hood.
2. A current sensor shall alarm locally and at the DDCP, if the fan fails.

3.29 SEQUENCE OF OPERATION – STRATIFICATION FAN SYSTEMS

1. Stratification fans shall be interlocked with the heating section of the air handling units they are associated with. The stratification fans shall operate whenever the associated air handling unit is providing heat into the space.

3.30 SEQUENCE OF OPERATION – PREP ROOM EXHAUST SYSTEMS

1. Prep room exhaust fans (including fume hood fans where fume hoods are located in prep rooms) shall operate continuously (24 hour/day, 7 days/week, 52 weeks/year).
2. A current sensor shall alarm locally and at the DDCP, if the fan fails.

3.31 SEQUENCE OF OPERATION – FUME EXTRACTION SYSTEM

1. The fume extractor shall be provided with a local manual switch, with pilot light, that shall energize and de-energize the respective exhaust fan through the DDCP.
2. The fan's VFD shall modulate the exhaust flow to maintain a constant negative pressure in the exhaust duct, regardless of the position of the various extractor arm dampers.

3. When the exhaust fan is de-energized, it shall continue to run for an additional 5 minutes (adjustable).
4. The motorized backdraft damper shall be interlocked to open when the fan runs.
5. When the fume extraction fan is energized, a motorized damper in the return ductwork of the associated H&V system shall close to reduce the return airflow by the exhaust airflow.

**3.32 SEQUENCE OF OPERATION – AUTOMOBILE TAILPIPE EXHAUST SYSTEMS**

1. Auto tailpipe exhaust system shall be provided with local manual switches, with pilot light, one at each tailpipe exhaust reel, that shall energize and de-energize the respective exhaust fan through the DDCP.
2. When all switches are in the off position, the exhaust fan shall be de-energized, and shall continue to run for an additional 5 minutes (adjustable).
3. The motorized backdraft damper shall be interlocked to open when the fan runs.
4. A current sensor shall alarm locally and at the DDCP, if the fan fails.
5. The exhaust fan variable frequency drive shall be stepped in response to the number of switches that are in the on position (representing the number of tailpipe exhaust reels in use). The steps shall be based on measured CFM at each of the active tailpipe reels, to ensure a minimum airflow as shown on the drawings at each active reel.

**3.33 SEQUENCE OF OPERATION – WING D VEHICLE STORAGE SYSTEMS – SUPPLEMENTAL BID**

1. Temperature sensors in the spaces shall control the operation of the gas-fired unit heaters in winter, and the exhaust fans in summer.
2. A carbon monoxide sensor shall energize the fans when the carbon monoxide in the space exceeds the threshold of 25 PPM (adjustable), as sensed by the space CO sensor.
3. The motorized backdraft damper shall be interlocked to open when the fans run.

**3.34 SEQUENCE OF OPERATION - VARIABLE AIR VOLUME BOX**

1. Variable Volume Terminal Boxes
  - a. The VAV terminal unit shall be controlled within user defined maximum and minimum supply air volume settings. The zone controller shall monitor the room temperature sensor and air velocity sensor and modulate the supply air damper, independent of system supply pressure, to maintain the room temperature at set point. During warm-up cycle VAV box shall be fully opened.



- b. The zone controller shall increase VAV terminal unit airflow on a rise in space temperature. Upon a drop in space temperature below the set point, the terminal box shall modulate toward its minimum damper position.
  - c. The zone controller shall monitor the room carbon dioxide (CO<sub>2</sub>) sensor and override temperature control if CO<sub>2</sub> level rises above 1,500 PPM (adjustable). The zone controller shall increase VAV terminal unit airflow to maintain CO<sub>2</sub> level of 1,500 PPM (adjustable).
  - d. VAV terminal units serving Science Labs provided with fume hood exhaust shall fully open when exhausts are started.
2. Variable Volume Terminal Boxes with Hot Water Reheat Coils
- a. The VAV terminal unit is controlled within user defined maximum and minimum supply air volume settings. The zone controller monitors the room temperature sensor and air velocity sensor and modulates the supply air damper in sequence with the reheat valve to maintain the room temperature at set point.
  - b. The zone controller shall increase VAV terminal unit airflow on a rise in space temperature. Upon a drop in space temperature below the setpoint, the terminal unit shall modulate toward its minimum damper position. Upon a further drop in space temperature, the zone controller shall modulate the associated reheat coil control valve and supply air damper to open position.
  - c. The zone controller shall monitor the room carbon dioxide (CO<sub>2</sub>) sensor and override temperature control if CO<sub>2</sub> level drops below 1,500 PPM (adjustable). The zone controller shall increase VAV terminal unit airflow to maintain CO<sub>2</sub> level of 1,500 PPM (adjustable).

### 3.35 LABORATORY AIRFLOW CONTROL SYSTEM

1. Scope of Work
- a. The system shall be based on the constant volume control of exhaust fume hood, synchronization of supply and exhaust airflows, and control of lab room temperature via VAV boxes and central station air handling unit. The laboratory rooms shall be maintained at a negative pressure with respect to the surrounding spaces.
  - b. All control equipment required to fulfill this specification shall be manufactured and provided by the Laboratory Airflow Control Equipment Manufacturer.
  - c. Equipment shall be supplied to the Mechanical Contractor.
  - d. Duct devices shall be installed by the Sheet Metal Contractor. Standard fittings, hangers, and ancillary devices required to install duct devices shall be provided by the Sheetmetal Contractor, in compliance with the contract documents.

- e. Monitoring and Control devices shall be installed by the Temperature Control Contractor. Standard fittings, hangers, and ancillary devices required to install duct devices shall be provided by the Temperature Control Contractor.
  - f. Equipment shall be commissioned by the Laboratory Airflow Controls Manufacturer.
  - g. The Laboratory Airflow Control Systems shall digitally interface to the Central Building Automation System (BAS) as provided by the Temperature Control Contractor. The Laboratory Airflow Control Contractor shall be responsible to provide an interface device between the Laboratory Airflow Controls and the BAS, including standardized communications protocol software and data mapping tables as required by the BAS design. The Temperature Controls Contractor shall be responsible to provide interface devices, drivers for either ModBus or BacNet protocols, software indigenous to the BAS, and graphic displays for the Laboratory Airflow Control Systems at the central BAS station.
  - h. If items in the specifications or drawings require clarification, the effected contractors shall contact the Architect/Engineer for clarification.
  - i. Acceptable Manufacturers: Tek-Air Systems, Inc. or approved equal.
2. General:
- a. The Laboratory Airflow Control system shall include the following components:
    - 1) Exhaust Air Flow measurement.
    - 2) Supply Air Flow measurement.
    - 3) Static pressure measurement between Laboratory and surrounding areas.
    - 4) Exhaust Static Pressure Sensor and Transmitter.
    - 5) Lab Interface Module with Repeater and Communications Access Port.
3. Exhaust and Supply Airflow Measuring Devices
- a. Airflow measuring devices of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume, shall be provided where indicated. Airflow measuring devices shall be of the insertion type, or built into airflow control valves, as required, with the capability of measuring velocity over the full range of 350 to 7000 FPM. Devices shall consist of multiple velocity sensors, supported on insertion probe bars.
  - b. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars, as required to achieve an equal area traverse. Standard Materials shall be aluminum bars with aluminum and ABS sensors. Support bars over one foot in length shall be supported on both ends. Where utilized in corrosive air streams, sensors and support bars shall be manufactured of corrosion resistant CPVC and ABS. All mounting hardware required shall be furnished by the Laboratory Airflow Control System Manufacturer.

- c. Individual velocity sensors shall not be effected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.
- d. Multiple sensors shall be utilized in all ducts with areas over .3 square feet in accordance with the following recommendations:
- | AREA         | RECTANGULAR | CIRCULAR |
|--------------|-------------|----------|
| less than .3 | 1           | 1        |
| .3 to .8     | 2           | 2        |
| .8 to 3.0    | 4           | 4*       |
| 3.0 to 5.0   | 6           | 4 or 8*  |
| 5.0 to 8.0   | 8           | 8*       |
| 8.0 to 15.0  | 12          | 8*       |
| 15.0 to 32   | 16          | 12**     |
- Note \*: Two support bars in a cross pattern  
Note \*\*: Three support bars in a cross pattern
- e. Where sensors are installed at the inlet of Pneumavalve airflow control valves, fewer sensors are allowable due to improvement of airflow profile by vanes in Pneumavalve.
- f. Velocity measurements from individual sensors shall be summed in the associated Airflow Controller via integral Airflow Measurement circuitry. The measurement shall be input and conditioned digitally to eliminate Analog-to-Digital conversion error. The airflow measurement shall be incorporated in the control sequence as performed by the Airflow Controller, and communicated to other Airflow Controllers, via the network, as required. Measurement system accuracy shall be plus or minus 2% of volumetric airflow rate. Turndown capability shall be at least ten to one.
- g. Velocity sensing methods other than those specified shall be acceptable, provided the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal are met. If differential pressure devices are used, dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME guidelines for up and downstream conditions.
- h. Pitot devices constructed of aluminum are not acceptable in the fume hood exhaust air; 304 stainless steel shall be used.
- i. The airflow sensors shall be easily removed from the duct for inspection. If this is not possible, then access doors must be installed in the duct upstream and downstream of the airflow sensor.
- j. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.

- k. Sensing methods employing thermal devices in the airstream shall not be acceptable.
4. Static Pressure Sensors & Transmitter
- a. Provide, where indicated on the plans and where required, static pressure transmitters that are of the correct range for the associated pitot static measuring device. The transmitters shall be capable of being field re-calibrated and have pressure ranges of -0.1" w.c. to 0-5" w.c. The transmitter shall have 0.5% accuracy.
    - 1) The device shall be a 2-wire device and shall be temperature compensated 35 Of - 135of.
    - 2) The duct static pressure probe shall be T-SPP7100 which is an averaging static pressure probe that provides multiple fechheimer static sensing points. The probe shall be constructed of stainless steel.
5. Lab Interface Module (Repeater/ Communications Access Port)
- a. Wall mounted module shall contain a Communications Repeater, capable of handling data at up to 625 kilobits per second, with terminals for connecting the repeater in series with Network, The Module shall also provide a local Communications Access Port receptacle connection for a programming device. The module shall provide access to the Lab Control Network and allow the operator to call any Lab Controller from one location.
  - b. Digital Communications Interface
    - 1) Building Automation System Interface - The Laboratory Airflow Control Systems shall digitally interface to the Central Building Automation System (BAS) as provided by the Temperature Control Contractor. The Laboratory Airflow Control Contractor shall be responsible to provide an interface device between the Laboratory Airflow Controls and the BAS, including standardized communications protocol software for either ModBus or BacNet, and data mapping tables as required by the BAS design.
    - 2) The following Lab Control Parameters shall be transferred digitally to the BAS:
      - a) Emergency status
      - b) Exhaust Airflow, CFM and setpoint
      - c) Supply Airflow, CFM and setpoint
      - d) Static Pressure reading and Setpoint
      - e) Static Pressure alarm

- 3) The Temperature Controls Contractor shall be responsible to provide digital interface devices, drivers for interfacing with ModBus or BacNet protocols, software indigenous to the BAS, and graphic displays for the Laboratory Airflow Control Systems at the central BAS station.
- 4) Hardwire interfacing of Lab Control Systems to BAS shall only be acceptable if:
  - a) All parameters outlined in par. 2 above shall be transferred to the BAS.
  - b) The Lab Control Contractor shall provide, in their Bid price, all additional equipment required on the part of the ATC for interface to the Lab systems, including ATC control panels.

6. Execution

- a. A factory-trained representative of the Laboratory Airflow Control Manufacturer shall functionally check all controls prior to setup by the test and balance contractor.
- b. All controls shall operate without cycling or hunting.
- c. The representative of the Laboratory Airflow Control manufacturer shall demonstrate to the engineer the ability of the controls to maintain setpoints in all modes of operation.

3.34 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 24 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required during the maintenance period at no additional cost to the owner. The Maintenance period shall be defined as the warranty period per phase of the project refer to specification section 011100.

3.35 MAINTAINENCE

1. The contractor shall maintain the controls equipment during the warranty period. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner.
2. The contractor shall maintain the control and software equipment until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.

3. The maintenance shall include but not be limited to monthly tests, programming, equipment checks, phasing test for the addition of new equipment, controls and programming, and function.

END OF SECTION

SECTION 23 20 00 - PUMPING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training.
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, general provision, and with the provisions of all applicable codes and laws.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Centrifugal pumps.
  - b. Air Conditioning Condensate Pumps.
  - c. Pump related accessories.
  - d. Pump curves.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000.

PART 2 - PRODUCTS

2.01 GENERAL

1. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.

2. Provide casing connections for vent, drain, suction and discharge pressure gauges.
3. Balance impellers and all other moving components statically and dynamically.
4. Completely align and level pumps, motors and bases. Where pumps and motors are shipped as a unit, realign them in the field.
5. Install and align mechanical seals in accordance with the manufacturer's recommendations.
6. Provide water supply for cooling and lubricating of seals and/or packing.
7. Match centrifugal pump impellers and casings so that at specified operating conditions, the impeller diameter is not more than 90% of the maximum diameter impeller which can satisfactorily operate in the casing.
8. Pumps must operate stably without pulsation, vibration or internal recirculation. Pump operating characteristics at the design point must be such that a variation of 10% in head results in not more than 15% variation in GPM and does not affect the stability of operation of the pump.
9. Motor sizes scheduled are minimum for the specific pumps indicated on pump schedules. When submitting pumps other than those specifically selected, size motors so that when operating at rated RPM, the pump motor brake horsepower does not exceed the nominal motor rating despite variations in pumping head or when operated singly or in parallel with other pumps serving the same system.
10. Motors to be high (premium) efficiency type with guaranteed minimum efficiency rated in accordance with IEEE standard 112, method B - General Electric Company "Energy Saver" or equal.

2.02 PUMP - CENTRIFUGAL - END-SUCTION - SINGLE STAGE, STANDARD CONSTRUCTION

1. Single suction base mounted single stage centrifugal type with pump flexibly coupled to the motor and the assembly mounted as a unit on a cast iron or formed steel base plate. Provide a steel coupling guard bolted to the pump base plate.
2. Casing - Cast iron volute, vertically split, bolted at the division, replaceable bronze wearing rings locked on.
3. Pressure ratings - minimum 125 PSI WWP, 125 PSI ANSI-Standard flanged or screwed connections.
4. Impellers - Fully enclosed, bronze, keyed to the shaft.
5. Shaft - Alloy steel, ground smooth.



6. Shaft sleeves - aluminum bronze locked on the shaft extending from the impeller through the shaft seal.
7. Mechanical seals - Ni-resist and carbon sealing faces, Crane Packing Co. type 1. Provide water lubrication by copper tubing connections with casing.
8. Bearings - Heavy duty grease lubricated ball type. Protected from water by slinger rings on shaft.
9. 

Manufacturer:	Model/Series:
Bell & Gossett	1510
Peerless	F
Weinman	500

2.03 PUMP - CENTRIFUGAL INLINE

1. Single suction, close coupled centrifugal type with pump bolted to the motor housing, and the complete assembly mounted as a unit.
2. Fully enclosed bronze impeller keyed to a stainless steel shaft.
3. Shaft seal: Mechanical, designed for hot water service to 230<sup>o</sup>F.
4. 

Manufacturer:	Model/Series:
Bell and Gossett	60, 80, 90
Peerless	PV
Weinman	320

2.04 AIR CONDITIONING CONDENSATE PUMP (SMALL)

1. Complete assembly of receiver, pump, and motor float switch.
2. Receiver shall be ABS plastic with 1 gallon capacity.
3. Vertical type pump shall be constructed with stainless steel shaft bronze bearing and Polypropylene impeller. Pump shall be capable of 125 GPH at 9 ft. head.
4. Motor shall be 1/50HP, 1750 RPM, 120 volts, single phase, 60 Hz, with built-in overload protection.
5. Pump features a safety switch that can be connected to shut down the air conditioner condenser or wired to an alarm to warn of possible tank overflow.
6. Discharge shall be a 3/8" O.D. barbed tubing adapter. Pump shall be rated for high-efficiency gas furnace applications that produce an acidic condensate.
7. Thermally protected motor shall be UL and CSA listed.

8. Manufacturer:  
Little Giant  
Zoeller Pump Co.  
Beckett

#### 2.05 SEPARATORS FOR MECHANICAL SHAFT SEALS

1. Provide a separate high efficiency stainless steel centrifugal separator with inlet and discharge shut-off valves in the copper water tubing connections to each of the pumps mechanical shaft seals.
2. Bolt each separator securely to a steel angle mounting bracket bolted to the pump casing.
3. The separator tubing and valve assembly shall be of copper and have a pressure rating equal or greater than the pumps.
4. The separator shall be manufactured by the John Crame Company specifically to protect mechanical shaft seals by removing abrasive solids.
5. Provide filter assembly in lieu of separator for pumps that do not develop sufficient differential pressure for proper separator operation. Filter assembly to be as manufactured by AMF Cuno. Provide two additional replacement cartridges per assembly.

### PART 3 - EXECUTION

#### 3.01 EQUIPMENT

1. Install equipment in conformance with manufacturer's recommendations.

#### 3.02 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 18 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required for maintenance during the Warranty period.

#### 3.03 MAINTENANCE

1. The contractor shall maintain the pumping equipment during the warranty period. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner.

2. The contractor shall maintain the pumping equipment until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.
3. The maintenance shall include but not be limited to monthly greasing, equipment checks, phasing test for the addition of new equipment and piping, and cleaning.

END OF SECTION

SECTION 23 25 00 – SPECIALTIES AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.
2. The installation and equipment is to conform to applicable building Code articles and applicable reference standards cited therein.
3. Conform to the applicable performance standards, listing or approvals of the following organizations where cited in the Sections or on Drawings.

Underwriters Laboratories (UL)  
National Fire Protection Association (NFPA)  
American Society for Testing Materials (ASTM)

1.03 SUBMITTALS

1. Procedure
2. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
3. Shop Drawings
  - a. Water treatment equipment components, trim, controls and performance data.
  - b. A complete list of all chemicals to be used.
  - c. Readings required on all indicating instruments for proper operation.
  - d. Equipment maintenance requirements.
  - e. Provide complete wiring diagrams for use by the electrician in connecting motors and equipment.

- f. Complete piping diagrams for use by the Mechanical Contractor in installing interconnecting piping, tanks, pumps and metering devices.
- g. Certification, on the company's letterhead, of qualifications of key personnel.
- h. Electric tracer cable

1.04 SYSTEM TESTING

- 1. Perform operating tests and instruct Owner's personnel as specified in Section 230000.

PART 2 - PRODUCTS

2.01 WATER TREATMENT

- 1. General requirements.
  - a. The water treatment contractor shall provide a supervised water treatment program for a period of one year from the date of initial treatment, for the systems and/or equipment indicated hereafter.
  - b. The water treatment company shall have at least one officer or official holding a college or university degree in chemistry, chemical engineering, or sanitary engineering. He should have at least ten years experience in treating the water in systems of similar size and capacity, and he shall be in active responsible charge of all treatment work.
  - c. The company's laboratory shall be equipped to analyze samples in accordance with the standard methods of the American Water Works Association and the American Society for Testing Materials.
  - d. The water treatment contractor shall supply all feeding equipment including tanks, pumps, interconnecting piping and wiring, metering devices and accessories necessary to make a complete operable system. The Mechanical Contractor shall be responsible for installation of the above equipment and shall provide all piping, valves, fittings, switches and miscellaneous equipment shown on the water treatment company's drawings but not supplied by the water treatment company.
  - e. The water treatment company shall provide the following services:
    - 1) Provide the Owner with complete written instructions for chemical feeding bleed-off and testing procedures.
    - 2) Demonstrate to Owner's personnel the proper application of written instructions.
    - 3) Provide all chemicals, chemical feeding equipment and testing equipment, as described in the following paragraphs. The products shall be biodegradable compounds.

- 4) Obtain samples from all systems, at least once per month, analyze these samples and furnish written reports and recommendations to Owner and/or Engineer.
- 5) Instruct Mechanical Contractor on installation of feeding equipment.

2. Initial Cleanout.

- a. All new recirculating water systems, both open and closed, shall be filled and flushed with a 0.25 solution, by weight, of a non-foaming chemical detergent, to remove all foreign matter.
- b. Solution shall be circulated for a minimum of 8 hours and drained as rapidly as possible to remove all suspended matter.
- c. The system should be flushed with fresh water, drained a second time and refilled. After final filling, the PH of the water shall not exceed the PH of the fresh incoming water by more than 0.5 PH.

3. Chemicals

- a. Condenser water system.

Organic inhibitor program

Treatment and Chemical Conditions	Control Level
Non-toxic organic corrosion and scale inhibitor - Vaporene 72 or organic inhibitor equal	300 PPM as total inhibitor
Organic flocculating agent Vaporene D-680 or equal	1 PPM
Organic growth	None *
Cycles of concentration	7 max.

\* Apply non-oxidizing Environmental Protection Agency registered dioxide when necessary - Vaporene W or equal.

- b. Hot and chilled water

Treatment and Chemical Conditions	Control Level
Non-chromate corrosion inhibitor Vaporene N liquid or equal	500 PPM nitrite (Hot water 1000 - 1200 PPM nitrate)

- c. Testing equipment specifications: Provide a complete testing station which shall include the necessary field test equipment for maintaining control of treatment standards and cycles of concentration as above. Test kits shall be supplied by the water treatment contractor and remain the property of the Owner.
4. Condenser Water System
- a. Mechanical Contractor shall install on the condenser water system a complete package prepiped, prewired automatic feed system and controller supplied and manufactured by the water treatment contractor for single source responsibility for treatment feed equipment and service to insure compatibility. Controller shall be Metro-Matic Tower Tender, or equal.
  - b. The controller shall automatically control chemical feed and bleed-off from the condenser water system by synchronization of feed and bleed to prevent any disparity between rate and bleed-off rate for accurate control.
  - c. Controller shall have a fail-safe back-up control and warning alarm in event of operational malfunctions.
  - d. Controller shall be a fully integrated system with automatic measurement of makeup water to fluid coolers by meter installed on the makeup line to the cooler sump for primary control of inhibitor level and cycles of concentration. Fail-safe back-up control shall consist of conductivity monitor with override of primary control.
  - e. Controller shall be factory prepiped and prewired and include the following:
    - 1) Control center consisting of reset timer for control of feed and bleed cycle activated by contact head water meter, relay and three position mode switch: Hand-Off-Auto.
    - 2) Inhibitor feed pump Precision 83II-11 diaphragm type controlled volume pump PVC-acrylic, 0.8 GPH capacity, 100 PSI, 1-60-115V capacity adjustable 0-100 percent variation.
    - 3) Watertight junction box with numerically marked terminals for simple electrical installation with terminals for wiring to water meter, solenoid bleed and warning alarm.
    - 4) Pressure switch, adjustable 0-150 PSI 320 PSI test.
    - 5) Fail-safe backup conductivity monitor and controller solid state prewired to reset timer with warning device when conductivity exceeds preset level for preset period of time.
    - 6) Plug-in type conductivity sensor in flow-through cell holder 125 PSI with drain cock prepiped and prewired.

- 7) Indicator lamps indicating operating mode power-pressure-water meter-conductivity-warning.
- f. The controller shall be installed by the Mechanical Contractor as outlined on the Drawings (See Metropolitan Refining Co., Inc. Drawing #11171 A & B) with the following additional external equipment supplied by the water treatment contractor.
- 1) Water meter or makeup water line to cooler sump in a by-pass. Meter shall be sized for operation at maximum makeup rate to cooler with electriccontact switch in the register. Neptune Trident with design 2l alarm register, Niagara Type R6D, or equal.
  - 2) Solenoid bleed-off valve on bleed-off line from spray water return line sized for capacity of system. Asco, Magnetrol, or equal.
  - 3) Ball flow indicator on bleed-off line from condenser water return line of suitable capacity for system. SK Instruments, Dwyer, or equal.
  - 4) Corporation stop injection nozzle assembly 1/2" PVC injection nozzle with 3/4" NPT male connection to the main line for injecting inhibitor into condenser water return line down stream from bleed-off line. Precision #992, or equal.
5. Closed Systems
- a. Hot and chilled water system: Mechanical Contractor shall install across the recirculating pump a 5-gallon by-pass feeder 250 PSI test pressure with 2" fill line and cap, as outlined on the Drawings. (See Metropolitan Refining Co., Inc. Drawing #11162).
6. Service Contract
- a. Furnish test unit with apparatus for treatment control of all chemical formulas supplied.
  - b. A service contract shall also be furnished at the end of the last phase of construction for a one-year period which shall include the following: Initial water analysis and recommendations, treatment chemicals, system start-up assistance, training of operating personnel, periodic field service and consultation.

## 2.02 ELECTRICAL TRACERS FOR FREEZE PROTECTION

1. To be provided on all outdoor piping: (2) 16 AWG copper bus wires embedded in parallel in a self regulating polymer core that varies its power output to respond to temperature along its length. The system shall permit crossing of cable without overheating. The heater cable shall be covered by a radiation cross linked modified polyolefin dielectric jacket.



2. All components shall be U.L. listed. See Electrical Drawings for location.
3. Rating: Adequate to maintain minimum 40°F in lines protected.
4. Cable manufacturer: Raychem XL-Trace or the approved equal of Chemelx.
5. Control: The heater cable shall have a self-regulating turn down factor of 90%.
6. Thermostat manufacturer: Chromalox Type PIT-15 raintight thermostat.
7. Form a loop and wrap tracer cable around piping, fittings and valves according to manufacturer's recommendations with the following required length of cable allowed for each size gate/globe valve or strainer as listed.

1" valve = 3'-0" tracer cable  
4" valve = 8'-0" tracer cable  
8" valve = 15'-0" tracer cable

Minimum watt density

<3":	5.0 watts/ft.
4":	5.0 watts/ft.
6":	8.0 watts/ft.
8":	(2) @ 5.0 watts/ft.
up to 14":	(2) @ 8.0 watts/ft.

8. For further installation details of cable and controls refer to manufacturer's recommendations.

### PART 3 - EXECUTION

3.01 Install equipment in conformance with manufacturer's recommendations.

#### 3.02 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 18 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required for maintenance during the warranty period.

3.03 MAINTENANCE

1. The contractor shall maintain the equipment during the warranty period. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner.
2. The contractor shall maintain the equipment until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.
3. The maintenance shall include but not be limited to monthly greasing, equipment checks, phasing test for the addition of new equipment and piping, and cleaning.

END OF SECTION

SECTION 23 30 00 - DUCTWORK AND AIR OUTLETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the Contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Typical duct construction details (elbows, taps, splits, transitions, plenums, supports).
  - b. Ductwork layouts at 3/8" scale, with match lines as necessary to maintain maximum sheet size of 48x36.
  - c. Fire dampers and sheet metal hardware.
  - d. Volume & motorized dampers, accessories and access doors.
  - e. Combination fire/smoke dampers and accessories.
  - f. Grilles, registers, diffusers and terminal outlets.
  - g. Casing construction details.
  - h. Acoustical lining and application methods.
  - i. Air duct leakage test procedures.
  - j. Air duct leakage test report.
  - k. Air balance contractors qualifications, procedures and report format.
  - l. Air balance report.
  - m. Dust collector and accessories.
3. Samples
  - a. Typical finished grilles and terminal air distributing devices. Color samples for pre-finished items. Samples will not be returned, nor used in the project.

4. Sheetmetal shop drawings shall be coordinated, showing the work of other trades, including but not limited to, sprinklers, light fixtures, conduits, structural steel, plumbing and HVAC piping. Refer to specification section 230000 1.15, Coordination drawings, for submission requirements.
5. Sheetmetal shop drawings shall be submitted on drawings no larger than 48" long by 36" high, at minimum 3/8"=1'-0" scale. Provide match lines and key plans as required.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000. Produce and maintain ventilation and air conditioning under operating criteria.

PART 2 - PRODUCTS

2.01 RECTANGULAR DUCTWORK

1. Construct all ducts and casings of lock forming quality sheet, light commercial galvanized coating class - ASTM - A525, 526, 527; stainless steel sheet ASTM - A480; aluminum sheet Alloy 3003-H-14. Metal thicknesses are U.S. Standard gauge. Duct joints, seams and reinforcing shall meet or exceed requirements as per SMACNA HVAC Duct Construction Standards 1995 edition.
2. Duct construction shall follow standards set forth in Tables 1-5 through 1-13M of SMACNA HVAC Duct Construction Standards 1995 edition. Ductwork shall be fabricated for the pressure and minimum gauge listed below. Minimum pressure construction shall be + 2" WG.

3. Minimum gauges for rectangular ducts and fittings - 2" w.g. where either dimension is:

STEEL	ALUMINUM	DUCT DIMENSION	FLUSH SEAM
No. 26 ga.	24 ga.	Up to 12"	Up to 18"
No. 24 ga.	22 ga.	13" to 30"	19" to 30"
No. 22 ga.	20 ga.	31" to 54"	31" to 42"
No. 20 ga.	-	55" to 84"	43" to 60"
No. 18 ga.	-	85" and larger	-

4. Minimum gauges for rectangular ducts and fittings - 2" to 4" w.g. where either dimension is:

STEEL	DUCT DIMENSION
No. 24 ga.	Up to 12"
No. 22 ga.	13" to 30"
No. 20 ga.	31" to 54"
No. 18 ga.	55" to 72"
No. 16 ga.	73" and larger

5. Minimum gauges for rectangular ducts and fittings - 4" to 6" w.g. where either dimension is:

STEEL	DUCT DIMENSION
No. 24 ga.	Up to 12"
No. 22 ga.	13" to 30"
No. 20 ga.	31" to 54"
No. 18 ga.	55" to 72"
No. 16 ga.	73" and larger

**2.02 ROUND AND FLAT OVAL DUCTWORK**

1. Construct all ducts and fittings of lock forming quality sheet, light commercial galvanized coating class - ASTM - A525, 526, 527; stainless steel sheet ASTM - A480; aluminum sheet Alloy 3003-H-14. Metal thicknesses are U.S. Standard gauge.
2. Gauges for round and flat-oval ducts - low and medium pressure - unless noted otherwise on plans -

	SPIRAL LOCK SEAM	LONGI. SEAM
No. 26 gauge	Up to 8" dia.	---
No. 24 gauge	9" to 22"	Up to 8" dia.
No. 22 gauge	23" to 36"	9" to 22"
No. 20 gauge	37" to 50"	23" to 50"
No. 18 gauge	---	51" to 60"
No. 16 gauge	---	61" and larger

3. Gauges for round fittings.

No. 20 gauge	up to 36" dia.
No. 18 gauge	37" to 50"
No. 16 gauge	51" and larger.

**2.03 DUCT CLASSIFICATION**

1. The following ductwork shall be constructed to commercial SMACNA standards for internal pressures of + 4 inches of static pressure (water gauge):
- a. Air handling unit to supply risers (horizontal mains).
  - b. Supply duct risers.
  - c. Supply ductwork horizontal mains.
  - d. Exhaust ductwork (dust removal).
2. The following ductwork shall be constructed to commercial SMACNA standards for internal pressures of + 3 inches of static pressure (water gauge):
- a. Supply ductwork horizontal mains.
  - b. Supply ductwork downstream of VAV boxes, fan terminal boxes, reheat coils.
  - c. Return ductwork
  - d. Relief ductwork
  - e. Exhaust ductwork.

2.04 DUCT SEALING

1. The following ductwork shall be sealed to SMACNA Seal Class A.
  - a. Air handling unit to supply risers (horizontal mains).
  - b. Supply duct risers.
  - c. Supply ductwork horizontal mains.
  - d. Exhaust ductwork (dust removal).
  
2. The following ductwork shall be sealed to SMACNA Seal Class B.
  - a. Supply ductwork horizontal mains.
  - b. Supply ductwork downstream of VAV boxes, fan terminal boxes, reheat coils.
  - c. Return ductwork
  - d. Relief ductwork
  - e. Exhaust ductwork.

2.05 VOLUME DAMPERS

1. General - provide in ALL branch duct connections at mains to control and adjust the total volume of the system. Outlet dampers shall not be used for system adjustment.
  
2. Single Blade Dampers. Maximum width of single blade shall be 14", use opposed blade damper for height exceeding 14". Pre-manufactured dampers shall be part of an assembly complete with damper, frame, axle and bearings. The damper frame shall be installed internal to the duct and fastened with the appropriate hardware. The installation shall not interfere with the operation of the damper blade(s). Approved products for pre-manufactured devices are as follows:

Device	Manufacturer	Model
Rectangular	Air Balance	AC-111
	Greenheck	MBD-15
	Ruskin	MD25
Round	Air Balance	AC-112
	Greenheck	MBDR50
	Ruskin	MDRS25

3. Multiple Blade Dampers. Opposed blade damper shall be used where duct height exceeds 14". Approved products for pre-manufactured devices are as follows:

Opposed Blade	Air Balance	AC-2
	Greenheck	MBD-15
	Ruskin	MD35OB

4. On uninsulated round ducts, equip dampers with heavy duty locking quadrant. The locking quadrant shall be mounted on a 2" x 3" x 1/8" stand off plate held to duct in a manner so as not to interfere with the operation of the damper blade. Hardware for the manual volume dampers shall be as follows:

Duct diameter	Shaft size	Quadrant
All sizes	per manufacturer	Ventlok #555/560

Other acceptable manufacturers:

Young Regulator	Quadrant (404-SS)	Bearings (429/666)
Duro Dyne	Quadrant (KS Series)	Bearings (SB Series)

5. On uninsulated rectangular ducts, equip dampers with heavy duty locking quadrant and one close end gasketed damper bearing. The end bearing be mounted on a 4" x 4" x 1/8" plate held to duct in a manner so as not to interfere with damper blade operation. The locking quadrant shall be mounted on a 2" x 3" x 1/8" standoff plate held to duct in a manner so as not to interfere with the operation of the damper blade. Hardware for the manual volume dampers shall be as follows:

Duct dimension	Shaft size	Quadrant	Bearings
Up to 18 inches	3/8"	Ventlok #555/560	Ventlok #609
19" & larger	1/2"	Ventlok #555/560	Ventlok #609

Other acceptable manufacturers:

Young Regulator	Quadrant (404-SS)	Bearings (429/666)
Duro Dyne	Quadrant (KS Series)	Bearings (SB Series)

6. On insulated round ducts, equip dampers with heavy duty locking quadrant. The locking quadrant shall be mounted on an 8" x 8" x 1/8" stand off plate. The standoff shall be the insulation thickness plus 1/2". The plate shall be held to duct in a manner so as not to interfere with the operation of the damper blade. Hardware for the manual volume dampers shall be as follows:

Duct diameter	Shaft size	Quadrant	Bearings
All sizes	per mfg'r	Ventlok #555/560	Ventlok #607&609

Other acceptable manufacturers:

Young Regulator	Quadrant (404-SS)	Bearings (429/666)
Duro Dyne	Quadrant (KS Series)	Bearings (SB Series)

7. On insulated rectangular ducts, equip dampers with heavy duty locking quadrant and one close end gasketed damper bearing. The locking quadrant shall be mounted on an 8" x 8" x 1/8" stand off plate. The standoff shall be the insulation thickness plus 1/2". The end bearing be mounted on a 4" x 4" x 1/8" plate. Both plates shall be held to duct in a manner so as not to interfere with damper blade operation. Hardware for the manual volume dampers shall be as follows:

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Duct dimension	Shaft size	Quadrant	Bearing
Up to 18 inches	3/8"	Ventlok #555/560	Ventlok #607&609
19" & larger	1/2"	Ventlok #555/560	Ventlok #607&609

Other acceptable manufacturers:

Young Regulator	Quadrant (404-SS)	Bearings (429/666)
Duro Dyne	Quadrant (KS Series)	Bearings (SB Series)

8. Cable operated dampers (COD) shall be provided where indicated on plans, and/or where required due to damper location above/behind finished construction, where access to damper would require access door in finished construction. Rectangular dampers shall have opposed blade action. Dampers shall be equipped with internally controlled operators and cable. Cable shall terminate at face of outlet.

Manufacturer	Model
Anemostat	OB-ASL
Young Regulator	830A-CC w/270-275 operator
MAT	RT-250

9. Volume extractors shall be used where radius tap or split is not possible or where square elbows inlet and outlet throat radii vary by more than 15%.

Manufacturer	Model
Titus	AG-45 /AG-225
Krueger	EX Series
Anemostat	DT

**2.06 COMBINATION SMOKE/FIRE DAMPER - AIRFOIL BLADE - EXTERNAL RESET**

1. Damper to be combination UL classified fire damper and UL listed Class I smoke damper. Unit including operator shall be rated for 350°F.
2. Blades to be double skin airfoil shape 16 gauge galvanized steel construction mounted in 16 gauge galvanized channel. Unit to incorporate flexible blade and jamb seals, bronze or stainless steel bearings, 1/2" axle, blade interconnecting linkage out of air stream, 16 gauge galvanized steel sleeve.
3. Unit shall incorporate re-operable electric temperature sensor, blade end switches (open and closed), and outside the duct mounted UL listed operator. Operator to be compatible with sequence of operation as stated in Section 230923. Provide manufacturer's standard U.L. Listed open - close - reset switch and position pilot lights in unit mounted enclosure. Enclosure shall be capable of being removed for remote mounting to ensure visibility after system installation.
4. Unit shall meet UL 555, UL 555S, and NFPA90A requirements for fire and smoke dampers. Unit shall bear UL label.



- |    |  |   |
|----|--|---|
| 5. | Manufacturer:<br>Air Balance Inc.<br>Imperial<br>Greenheck<br>Ruskin | Model:<br>FA1 w/ Sens-O-Therm<br>770, 771 w/ Dual Override<br>FSD33 w/ TOR<br>FSD60 w/ TS-150 |
|----|--|---|

#### 2.07 ACOUSTICAL LINING

1. Sound insulation - where indicated on drawings, and within 10 lineal feet of fans, ductwork shall be lined with fiberglass duct liner of 2 lbs. per cubic foot density and covered with a fire resistant black coating that includes an EPA-registered antimicrobial agent bonded to fiberglass. Thickness of liner 1" in ducts, 2" in fan and outside air plena. Duct called to have thermal insulation, but also indicated on drawings for sound insulation shall receive sound insulation on inside only consisting of 1" thick fiberglass 2 lbs. density rigid duct liner with fire resistant coating that includes an EPA-registered antimicrobial agent bonded to fiberglass.
  

2.	Manufacturer: Owens Corning Certaineed Manville	Model: "Aeroflex" "Ductliner" "Linacoustic"
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#### 2.08 TERMINAL AIR DISTRIBUTING OUTLETS

1. Finishes - all exposed surfaces of terminal air distributing devices shall be finished as scheduled on drawings.
  - a. Baked enamel - chemically clean all surfaces after fabrication and apply rust resisting primer. Apply two finish coats of baked or heat-dried enamel of color and gloss matching Architect's samples.
  - b. Aluminum - anodized natural aluminum of uniform appearance and matching Architect's samples.
  - c. All ductwork accessories visible through the outlets are to be painted black.
2. Seal all air outlets around edges with foam rubber gaskets to minimize leakage.
3. Size and type - tabulated on the drawings.
4. Manufacturer:  
Anemostat  
Metalaire  
Titus  
Krueger

#### 2.09 ACCESS DOORS IN WALLS AND CEILINGS

1. At each control and balancing damper in ductwork, at each fire damper and volume box when located above ceiling or inside the wall not accessible by removal of grille or from the air shafts, furnish an access door for installation by the general contractor. Access

doors shall be 18" x 18"(minimum) unless otherwise indicated on plans; rigid construction with two hinges and a latch. In plenum ceilings, provide felt between the door and frame to make an airtight seal.

2. Door shall be suitable for flush mounting, prime coated with rust inhibitive paint, concealed frame, flush screwdriver operated locks with metal cams and anchors as required.
3.

Manufacturer:	Model:
Cesco	HF Series
J L Industries	FD Series
Milcor	M

**2.10 DUST COLLECTION SYSTEM**

1. Provide a complete Class I dust collection system consisting of dust collector, ductwork, blast gates, connections to equipment, and floor sweeps. Refer to Section 237000 for dust collector requirements.
2. Ductwork shall be constructed of round galvanized spiral ductwork.
3. Provide blast gate at each branch and as shown on plans. Blast gate to include means of locking in place after adjustment has been made.
4. Equipment connections and CFM ratings are as noted on the drawings. Equipment type and quantity to be confirmed with architect.

**2.11 DOUBLE WALL INSULATED ROUND AND FLAT OVAL DUCTWORK AND FITTINGS**

1. Construct all ducts and fittings of lock forming quality sheet, light commercial galvanized coating class - ASTM - A525, 526, 527. Metal thicknesses are U.S. Standard gauge.
2. Gauges for double wall round and flat-oval fittings.

INNER LINER DIAMETER	OUTER SHELL MINIMUM GAUGE	LINER MINIMUM GAUGE
Up to 12" dia.	No. 24 gauge	24
13" to 24"	No. 22 gauge	24
25" to 34"	No. 20 gauge	24
35" to 48"	No. 20 gauge	22
50" to 58"	No. 18 gauge	22
60" to 82"	No. 16 gauge	20

3. Inner liner shall be a perforated galvanized steel liner, with 3/32" perforations with an overall open area of 23 percent. Insulation shall be fiberglass, with a maximum thermal conductivity factor (k) of 0.27 BTU per hour per square foot per degree Fahrenheit per inch thickness at 75°F mean ambient temperature.

4. Round and flat oval double wall insulated ductwork and fittings shall be as manufactured by United McGill Corporation or approved equal.

### PART 3 - EXECUTION

#### 3.01 RECTANGULAR DUCT CONSTRUCTION - GENERAL

1. Make turns in main duct runs affecting the static of the system with elbows having a throat radius not less than the width of the duct.
2. Make turns in duct branch runs with elbows having a throat radius not less than one half the width of the duct or with square elbows with internal factory manufactured duct turns of a type acceptable to the Engineer.
3. Low and medium pressure ducts shall be constructed in a substantial and airtight manner with "Pittsburgh" and double locked longitudinal seams, properly hammered down. Other seams shall be SMACNA tables.
4. Make transitions and reducing sections of sufficient length to maintain the angle of deflection of any side less than 20 degrees.
5. Cut sheet metal screws extending inside accessible casing to be smooth and flush with inside of duct.
6. Make airtight, caulked connections between metal ducts and grilles or masonry.
7. Insulate joints between non-ferrous and galvanized iron materials with non-ferrous and galvanized iron angles separated with tar paper strips and fastened with non-ferrous stove bolts.

#### 3.02 DUCT ACCESSORIES, AND HARDWARE

1. Provide access doors to all equipment. Make doors not less than 16" x 16" where not otherwise sized on the drawings. Provide rigid pan construction with two hinges and latch. Provide access on entering and leaving sides of coil and heater sections, and at leaving side of volume boxes. Reinforce duct openings with angle iron frame. Where ducts are insulated, frame is to be raised to surface acting as an insulation stop. Provide felt between door and duct to make airtight seal when locked. Door shall be the double wall insulated type.
2. Latches similar to Ventfabrics, Inc. No. 100 for small doors and No. 310 where physical access is possible. Window latch type hardware is specifically prohibited except where the door swing for a hinged door is restricted by the hung ceiling or some other obstruction.
3. Provide 8" x 8" frame around damper quadrants in insulated ducts for insulation stop, of same height as insulation thickness.

4. Fan and unit connections - 30 oz. neoprene coated cloth connection with 2" clear distance, double wrapped, securely strapped to fan and cut and sewn airtight. Provide in each connection, including mixing box discharge.

### 3.03 DUCT SUPPORT

1. Rectangular ducts below 30 inches in width shall be hung with 1" x 1/8" galvanized strap iron bent 1" under bottom side of the duct and fastened to the duct with sheet metal screws using one on underside and not less than 2 screws per side and as many more needed so that they are no greater than 6" centers.
2. Rectangular ducts above 30 inches in width shall be hung with galvanized rods fastened to galvanized 1" angles running under the ducts as per detail.
3. Structural attachment of hanging rods and straps to be per detail. Friction type beam attachments for rod or strap hangers are not acceptable. Attachment to metal deck tabs is also not acceptable (refer to detail on plans).
4. Provide hangers on not greater than 8 feet centers.
5. Provide 18 gauge galvanized sheet metal escutcheon plates attached to ducts and on both sides around all exposed ducts passing through partitions, where visible, except within equipment rooms.
6. Provide 2" galvanized ground angles secured to floor on all ducts passing through floors.

### 3.04 BRACING OF RECTANGULAR DUCTS

1. Ducts shall be reinforced per SMACNA HVAC Duct Construction Standards 1995 edition Tables 1-5 through 1-13M.
2. Tie rods reinforcement shall be per SMACNA HVAC Duct Construction Standards 1995 edition Tables 1-5 through 1-13M.

### 3.05 ROUND AND FLAT-OVAL DUCTS

1. Round ducts with fittings and accessories are to be machine made, spiral type welded, factory manufactured by United Sheet Metal Co., or another acceptable to the Architect.
2. Make duct sections not longer than 20'-0".
3. Make elbows with welded sections using 5 pieces for 90 degree and 3 pieces for 45 degree turns and having a center line radius of one times the diameter of the duct.
4. Make joints in ducts with inside couplings not less than 6" long and seal joint with Minnesota Mining No. EC 800 adhesive or equal as recommended by the Supplier. Butt ends of duct tight to coupling bead.
5. Hang and encircle all round ducts with 1" x 1/8" galvanized strap iron. On ducts below 10 ft. circumference, clamp strap iron at top and hang with single rod. Above 10 ft.

circumference, clamp strap iron on both sides and hang with 2 rods. Provide hangers on not greater than 8 ft. centers unless noted otherwise on drawings.

6. Make all reducers and reducing fittings concentric and of sufficient length to maintain the angle of deflection of the perimeter below 15 degrees.
7. Make all other fittings including, rectangular to round transitions, access doors with sleeves, volume dampers, and fire damper to conform to manufacturer's standards.
8. Where ducts pass through floors use short length of duct for sleeve. Provide couplings and temporary caps at both ends.
9. Where ducts pass through walls provide sleeves using a coupling one size larger than duct and of length to conform to the thickness of the finished wall. Pack angular spaces with fiberglass insulation.
10. Factory, cut, reinforce, and provide flanges on main ducts for grille and branch connections.

### 3.06 FLUSH SEAM DUCTWORK

1. Provide flush seam ductwork for all ductwork where un-insulated and exposed in finished spaces or where required to maintain clearances.

Transverse joints

Thru 18"	Flush seam end slip, maximum 96" on centers.
19" thru 30"	Flush seam end slip stiffened with 1-1/4" x 3/8" bar, maximum 48" on centers.
31" thru 42"	Same as (2) above, spaced 36" on centers. Provide internal bracing between joints and at hangers.
43" thru 70"	Top-angle reinforced standby "S" slip. 1-1/2" x 1-1/2" x 1/4 edge. Sides and bottom--bar stiffened full "S" slip 1-1/4 x 3/8" bar, spaced 36" on centers. Provide internal bracing of 1" x 1/8" bar flat galv. bar. Everdur bronzed on centers, between joints and hangers.

### 3.07 STAINLESS STEEL DUCTWORK

1. Construct ductwork where indicated below from stainless steel in accordance with duct construction tables. Construct bars and angles from the same grade of stainless steel where exposed to the air stream. Construct supports and hangers of type 304 stainless steel.

- | 2. | System                    | Extent | Comment |
|----|---------------------------|--------|---------|
|    | Fume Hood Exhaust         | All    |         |
|    | Chemical Storage Cabinets | All    |         |
3. Locate all longitudinal joints above the center line of the duct. Solder or braze all joints watertight.
  4. Construct access doors of stainless steel with rubber watertight and airtight gaskets. Locate above the duct centerline.
  5. Do not penetrate the ductwork for hangers or supports.
  6. Horizontal ductwork to first elbow shall be pitched back towards the equipment. All other horizontal ducts shall be pitched in the direction of flow. Provide valved drains and hose bibbs at low points.

3.08 ALUMINUM DUCTWORK

1. Construct ductwork where indicated below from aluminum in accordance with duct construction tables. Construct bars and angles from aluminum. Construct supports and hangers of galvanized steel.

	System	Extent	Comment
	Boiler	All	Combustion air
	Toilet exhaust	All	
	Dryer Exhaust	All	Access doors 20 ft. on centers.
	Dishwasher exhaust	All	Access doors at 20' centers and drain points.
2. Locate all longitudinal joints above the center line of the duct. Solder or braze all joints watertight.
3. Construct access doors of aluminum with rubber watertight and airtight gaskets. Locate above the duct centerline.
4. Do not penetrate the ductwork for hangers or supports.

5. Horizontal ductwork to first elbow shall be pitched back towards the equipment. All other horizontal ducts shall be pitched in the direction of flow. Provide valved drains and hose bibbs at low points.

### 3.09 KITCHEN HOOD EXHAUST DUCTWORK

1. Formed 10 gauge black steel sheets with watertight flanged joints. Ducts shall be stiffened with 2" x 2" x 1/4" angles tack welded to the duct on all four sides, no less than 4'-0" on centers.
2. Provide clean outs at all changes in direction but no more than 10'-0" on centers.
3. Pitch horizontal duct sections in the direction of air flow; provide valved drains with hose bibbs at low points.
4. Support duct by 1/2" diameter steel rods, spaced not more than 4'-0" on centers, connected to the 2" x 2" x 1/4" steel angles.
5. All new kitchen hood grease duct shall be tested with a smoke bomb prior to being concealed with a wrap system or shaft.

### 3.10 ROUND AND FLAT-OVAL DOUBLE WALL DUCTS

1. Double wall round ducts and flat oval ducts with fittings and accessories are to be machine made, spiral type welded, factory manufactured by United Sheet Metal Co., or another acceptable to the Architect.
2. Make duct sections not longer than 20'-0".
3. Make elbows with welded sections using 5 pieces for 90 degree and 3 pieces for 45 degree turns and having a center line radius of one times the diameter of the duct. Elbows shall be standard product of manufacturer of double wall duct system.
4. Duct system shall be furnished with inner liner couplings and outer pressure shell couplings. Outer shell connections may be either slip joint or flanged joint, except flanged joints shall be used at ducts with outer shell diameters in excess of 36". Slip couplings shall join inner liner sections at duct to duct joints. Fitting liners shall be extended 2" beyond the outer shell cutoff to provide an inner liner coupling at duct to fitting joints. Flanged joints shall provide Van Stone connections to fittings, and shall be welded to duct.
5. Hang and encircle all round ducts with 1" x 1/8" galvanized strap iron. On ducts below 10 ft. circumference, clamp strap iron at top and hang with single rod. Above 10 ft. circumference, clamp strap iron on both sides and hang with 2 rods. Provide hangers on not greater than 8 ft. centers unless noted otherwise on drawings.
6. Provide all reducers and reducing fittings from manufacturer's standard offerings. Reducers shall be concentric and of sufficient length to maintain the angle of deflection of the perimeter below 15 degrees.

7. Make all other fittings including, rectangular to round transitions, access doors with sleeves, volume dampers, and fire damper to conform to manufacturer's standards.
8. Where ducts pass through walls provide sleeves using a coupling one size larger than duct and of length to conform to the thickness of the finished wall. Pack angular spaces with fiberglass insulation.

### 3.11 DUST COLLECTION DUCTWORK

1. Factory cut, reinforce, and provide flanges on main ducts for grille and branch connections.
2. Refer to round duct construction for details of duct construction.
3. Joints shall be lapped in direction of flow, riveted and soldered airtight.
4. Make connections to equipment as required, including transitions, offsets, etc.

### 3.12 TURNING VANES

1. Turning vanes shall be double wall construction of minimum 24 gauge galvanized metal. Each vane shall be securely riveted or welded to minimum 22 gauge runner or directly to duct.
2. Turning vanes shall have 2" inside radius spaced 2-1/8" apart through 36" wide duct. Vanes in elbows larger than 36" shall have a 4 1/2" radius and be spaced 3 1/4" apart.
3. Vanes shall be installed in sections to reduce unsupported length for duct depths exceeding 60".

### 3.13 TEST CONNECTIONS

1. On the discharge duct from each air handling unit downstream at least 5'-0" from unit if duct is accessible, or closer to unit if necessary, install a #699 Ventlock instrument test hold device for balancing and testing of system.

### 3.14 ACOUSTICAL LINING

1. Install sound insulation over adhesive, on welding pins not more than 12" O.C. with a minimum of two rows per side. Secure lining to pins with speed washers or clips. Apply 4" continuous strip of adhesive along edges at all joints and apply 50% coverage of adhesive between joints. Seal and caulk all joints between boards with adhesive at corners of ducts.
2. Interrupt lining at fire dampers. Insulate exterior of duct at liner interruption if duct requires insulation. Refer to Section 230700.



3. Duct mounted items such as dampers, turning vanes, and coils shall be installed on a continuous circumferential hat section of height equal to liner thickness and width to accommodate item. Provide liner section behind hat section or provide external duct insulation.
4. Provide continuous circumferential sheet metal protection nosing at all leading edges of lining.

### 3.15 COORDINATION AND COMPLETION

1. Conform to all applicable provisions of Section 230000 and coordinate with the requirements of the other mechanical work specification sections to provide complete operating systems.

### 3.16 AIR BALANCE

1. Balance all new air systems and those designated existing air systems to the quantities shown with the following tolerances:

Fans:	Design volume plus 5%
Outlets:	Design volume plus 5%
Leakage:	3% maximum.
2. Balance in accordance with ASHRAE, AABC or NEBB procedures and submit all readings.
3. Air system balancing is to be performed by a professional organization, other than the installing contractor, qualified by experience and practice to perform this service. Submit evidence of qualifications, balancing procedures, and report forms for approval prior to start of work.
4. Provide one extra set of drive sheaves per fan as part of the system balancing. Sheaves shall be installed as directed by the balancing subcontractor to achieve design CFM at the minimum RPM with an allowance for filter loading.
5. Submit three bound copies of the air balance report to the Engineer. Balance Report to include the following data for each fan system (supply, return, relief and exhaust).
  - a. System designation and location.
  - b. System description including areas served.
  - c. Manufacturer, model number, size designation, class and arrangement.
  - d. Supply/return/outside air CFM - Design vs. Actual (unit air quantities to be determined by duct traverse not sum of outlets - Submit data of traverse/minimum traverse points = 16 - max. distance between traverse points = 6")
  - e. Unit suction and discharge static pressure - design vs. actual.
  - f. Individual unit component static pressure drops (coils, filters, dampers)
  - g. Motor manufacturer, frame, horsepower, volts, phase, hertz and RPM.
  - h. Motor AMPS - design vs. actual.

- i. Fan RPM
  - j. Sheave and belt data.
  - k. Air outlet number, type, size, Ak, design CFM and velocity, intermediate velocity readings, final CFM and velocity.
  - l. Reduced plans with air outlets cross-referenced to number.
  - m. CFM, static pressure drop, (CFM and static pressure at minimum setting for VAV boxes) for all duct mounted items such as coils, VAV boxes, filters, induction units.
6. Items A. through E. above shall be furnished after each phase of the project. Refer to the phasing documents for timing and durations.

### 3.17 AIR DUCT LEAKAGE TEST

1. All supply ductwork from the supply air fan to the terminal boxes shall be inspected and have leakage testing performed by the testing, adjusting, and balancing (tab) agency.
2. The duct system testing shall be performed before the installation of duct insulation and ceilings. Testing shall be conducted at the design pressure of the ductwork being tested. Duct leakage test shall be coordinated with the various contractors through the HVAC contractor. The HVAC contractor shall prepare a schedule for testing indicating specific dates and procedures. The owner and architect shall be notified a minimum of two (2) weeks before testing is performed.
3. Procedures for conducting the leakage test shall be in accordance with SMACNA air duct leakage test manual. Procedures shall be submitted to the architect for approval prior to actual testing.
4. Maximum leakage shall not exceed the requirements for leakage class 3.
5. Leakage for non-duct components such as fire, smoke, and volume dampers, and terminal boxes is an integral part of the overall system leakage, and these components shall be included in the duct leakage tests.
6. Ductwork failing to meet the maximum leakage criteria shall be resealed and or reconstructed as required.
7. The tab contractor shall submit a report on the leakage test. The report shall include an accurate description of the test procedure and results, including recommendations for any remedial action required to meet the specified leakage criteria. Copies of certified calibration data for the leakage test apparatus shall be provided as part of the test report.
8. Items A. through G. above shall be furnished after each phase of the project. Refer to the phasing documents for timing and durations.

### 3.18 WIRING OF COMBINATION FIRE/SMOKE DAMPERS

1. The Division 23 mechanical contractor shall be responsible for all wiring of combination fire/smoke dampers, including all damper power as well as all damper control wiring.

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**DUCTWORK AND AIR OUTLETS**  
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2. Obtain sources of electrical power as directed on the electrical plans, in the electrical specifications, and herein. Provide such power wiring from the source of power to the dampers and associated controls as required for a complete system installation.
3. Confer with the Division 23 temperature control contractor to ensure damper control sequences are in accordance with the sequences of operation outlined in Section 230923.
4. The Division 23 mechanical and temperature control contractors shall be responsible for ALL damper control – this includes life safety shut-down and control, smoke purge / exhaust sequence control, as well as standard operation for specified temperature control sequences.
5. Refer to Section 230923 for additional requirements.

END OF SECTION

SECTION 23 50 00 - HEATING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the Contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Fuel oil tank and accessories
  - b. Radiation
  - c. Condensing Boilers
  - d. Heating plant accessories
  - e. Operating instruction including sequence of starting, stopping and shutdown.
  - f. Readings required on all indicating instruments for proper operation.
  - g. System maintenance requirements not covered by equipment manufacturer's instructions.
  - h. Provide complete wiring diagrams for use by the electrician in connecting motors and equipment.
  - i. Coordinate with the temperature control requirements in preparing these diagrams.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000. Produce and maintain ventilation and air conditioning under operating criteria.

**PART 2 - PRODUCTS**

**2.01 HEATING - GENERAL**

1. Match capacities, characteristics and dimension of all components to make a completely compatible system over its entire operating range.
2. Equipment shall be constructed and rated in accordance with AGA and IBR standards and applicable provisions of the ASME code.
3. Equipment shall comply with all state and local codes governing the performance of gas burning equipment, including the organizations listed in Section 230000.

**2.02 FUEL OIL STORAGE TANK**

1. The Insulated Secondary Containment Aboveground Storage Tank (AST) Systems for Flammable and Combustible Liquids, Protected Type: Vehicle Impact Protected, and Projectile Resistant shall be tested to and listed for the following:
  - a. UL - 142, aboveground steel tanks for flammable and combustible liquids.
  - b. UL - 2085, two-hour furnace fire test and two hour simulated pool fire test for insulated and protected tanks.
  - c. UL - 2085 and UFC Test Standard (Article 79 or APPENDIX #A-II-F-1), for both Vehicle Impact Protection and Projectile Resistance.
  - d. UL - 2085, protected aboveground tanks for flammable and combustible liquids.
  - e. UL - 2085, Non-Metallic Secondary Containment protected tanks for flammable and combustible liquids with secondary containment Emergency Venting by "Form of Construction".
  - f. The requirement for Uniform Fire Code (UFC) for two-hour (firewall) test.
2. The primary steel tank shall be rectangular in shape and have continuous welds on all exterior seams, manufactured in accordance with UL listing requirements and UL Standard 142. Primary steel tank capacity shall be 250 gallons.
3. The primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours.
4. The primary steel tanks shall have "emergency vent" system as per NFPA 30 Code requirements.
5. The protected and insulated AST systems shall have a thru-tank leak detector tube to allow for physical checkup and monitoring capability between the primary and the secondary containment.
6. The primary steel tank shall be pressurized at 5 psig during concrete encasement.

7. The outer surface of the primary steel tank shall be covered by a minimum of 1/4" thick (6.4 mm) Styrofoam insulation panels.
8. The secondary containment shall consist of a 30 Mil thick (0.76 mm) High-Density Polyethylene membrane enclosing the steel tank and insulation material.
9. The primary steel tank and the secondary containment shall be encased in six inches of monolithic reinforced concrete, with minimum design strength of 4,000 and 5,000 psi at 28 days depending on the tank size. The concrete design shall include the following for long-term durability: air entrainment, water reducing admixture, and steel reinforcement. Concrete encasements with seams will not be approved.
10. The protected and insulated AST systems shall be of concrete exterior and a continuous and visually verifiable monolithic (seamless) pour on top, bottom, ends, and sides and contain no cold joints or heat sinks (heat transfer points). The AST must be shop fabricated and tested in accordance with the UL listings. Designs that use two layers of steel with insulation material between them will not be approved.
11. No steel or insulating material shall come in contact with the concrete or other corrosive material.
12. All openings shall be from the top only.
13. All exposed metal with the exception of stainless steel must be powder coated to inhibit corrosion.
14. The protected and insulated AST systems shall include a 7 or 15-gallon powder coated or stainless steel, UL listed spill containment, and shall include normally closed valve to release spilled product into the primary steel tank. Spill containment which route the spilled product into interstitial area will not be approved.
15. The protected and insulated AST systems shall have a coated concrete exterior to resist weather and reflect sunlight. Models with steel exteriors will not be approved.
16. The protected and insulated AST systems shall have a warranty of 20 years with optional 30-year warranty.
17. The protected and insulated AST systems design shall have been in use for a minimum of twenty (20) years. The manufacturer must stipulate no reportable AST containment system failure in 30,000 units produced.
18. The protected and insulated AST systems shall have two (2) bolts for connecting grounding conductors for lightning protection in accordance with NFPA 780. Provide such grounding protection.

19.     Manufacturer:             Model:  
       ConVault                 AST  
       Phoenix

2.03    FUEL OIL ACCESSORIES

1.     Anti-Syphon Valve
2.     Foot Valve/Strainer
3.     Vent line and termination
4.     Direct Reading Level Gauge for tank mounting
5.     All fuel oil accessories must be in accordance with 2005 Connecticut Supplement and Connecticut State Statutes.

2.04    FINTUBE RADIATION: HOT WATER

1.     Type L, seamless copper tubing with aluminum or steel fins permanently bonded to the tube and guaranteed for a pressure of 200 PSIG with temperatures up to 250 °F. For pipe and aluminum fin sizes and capacity, see Schedule.
2.     16 gauge steel enclosure with spring clip fastening. No exposed fasteners.
3.     Prime coat and factory finished with baked enamel. Color to be selected by the Architect from manufacturer's samples.
4.     Accessories: Full 20 gauge backplate with urethane gasket, combination hanger/bracket with cradle and damper.
5.     Manufacturer: Sterling, Trane, Vulcan or approved equal.

2.05    CONDENSING BOILER

1.     General Description
  - a.     Each unit shall be a Down-fired Firetube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory package. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG. The boiler shall be CSA or cULus certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

- b. A circulation pump with VSD control shall be provided with each boiler. The pump must be able to provide a gpm between 145 and 580 gpm. The pump output shall be governed by the boiler Delta-T and controlled by the boiler control.
- c. The boiler shall be capable of operating with a 35% glycol mixture

2. Certifications

- a. Manufacturer's Certification: The boiler manufacturer shall certify the following:
  - 1) The products and systems furnished are in strict compliance with the specifications.
  - 2) The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package.
  - 3) ASME Certification in the form of ASME Stamp on the product and completed and signed data sheet.
  - 4) ASME CSD-1 Certification, in the form of completed data sheet.
  - 5) CSA or UL Certification in the form of an affixed label to the equipment.
  - 6) The specified factory tests have been satisfactorily performed.
  - 7) The specified field tests have been satisfactorily performed.
- b. Contractor's Certification: The contractor shall certify the following:
  - 1) The products and systems installed are in strict compliance with the specifications.
  - 2) The specified field tests have been satisfactorily performed.
- c. Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.
- d. Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain dimension and wiring drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, etc.

3. Boiler Design

- a. Boiler shall be a compact, single-pass, vertical down-fired Firetube type, with Duplex stainless steel tubes, tube sheets, and combustion chamber. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with powder coated finish. The boiler shall be a complete package boiler with assembled base, jacket, boiler stand for condensate neutralizer area and shall also include a fire test with Fire Test



Reports for submittals.

- b. The fire tubes shall be Duplex Stainless Steel and shall be fitted with Aluminum Alloy internal heat transfer fins creating no less than 10 square feet of fireside heating surface per boiler horsepower.
- c. The Vessel shall be mounted on a structural steel stand with exhaust gases collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion. A condensate neutralizing box complete with limestone chips shall be shipped loose for field installation by contractor. Note: A condensate trap assembly shall be furnished if a condensate collection tray is not provided due to operating conditions.
- d. The top tubesheet shall be fully accessible without burner disassembly or removal from the boiler. The burner assembly shall be complete with lifting hinges and pneumatic lifters. The boiler shall have a built in hinged platform allowing the operator to access the tubesheet, burner, ignition assembly and flame rod without the use of a ladder.
- e. The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.
- f. Boiler shall be built to State of Connecticut seismic zone requirements and manufacturer shall provide seismic calculations showing tie-down requirements for bolt diameters. Bolts and tie-down shall be by contractor.
- g. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.
- h. The boiler shall be designed for top rear water outlet and bottom rear water inlet; the water inlet [return] shall be equipped with internal baffling. Inlet connection size shall be 4" flanged. Outlet connection size shall be 4" flanged. The maximum pressure drop through the boiler shall not exceed 0.45 psi with a 20-degree differential and less than 0.05 psi with a 60-degree differential.
- i. The boiler shall be equipped with a second water return connection that will permit low temperature returns to be utilized for condensing, regardless of the primary return temperature water above condensing conditions.
- j. A threaded air vent connection shall be furnished at the top rear of the boiler for field piping to an expansion tank or for the addition of an auto-vent valve when a bladder type expansion tank is utilized.

- k. To drain the boiler, a bottom-threaded connection shall be provided at the front of the boiler and field piped by the installing contractor with a manual full size shutoff valve to drain.
- l. Boiler design shall permit operation with a water condition of 8.0 - 9.5 pH range.

4. Burner Design

- a. General: Forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tubes are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on hydraulic piston arms, one on each side to provide open support of the burner assembly.
- b. A drop down hinged service platform shall be furnished to provide service personnel an easy means of accessing the burner and controls for service and maintenance. When out of use, this platform shall fold up beneath the front service boiler panel.
- c. The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages, damper motor drives and single speed fans shall not be acceptable.
- d. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.
- e. Emissions: The equipment shall be guaranteed to limit NO<sub>x</sub> emissions to 20 PPM or less, as certified by an independent testing lab. NO<sub>x</sub> emission levels shall not be exceeded at full operating conditions and at designed turndown of the burner. Proof of such emissions certification shall be made available to the engineer and purchaser and demonstrated at the time of start-up. External flue gas recirculation shall not be accepted for emission control.
- f. Gas Train – As a minimum, the gas train shall meet the requirements of CSA/UL and ASME CSD-1 and shall include:
  - 1) Low Gas Pressure Interlock, manual reset.
  - 2) High Gas Pressure Interlock, manual reset.
  - 3) Upstream and downstream manual test cocks.
  - 4) Ball Type manual shutoff valve upstream of the main gas valve.
  - 5) Unibody double safety gas valve assembly.
  - 6) Gas Pressure Regulator

- 7) Union connection to permit burner servicing.
  - g. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner ignition firing.
  - h. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.
5. Boiler Trim
- a. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at 60 psig.
  - b. Temperature and pressure gauge shall be mounted on the water outlet.
  - c. Solid State Low water cut-off probe with manual reset and test switch.
  - d. Manual Reset High Limit Temperature sensor; range not to exceed 210<sup>0</sup> F and shall be an integral device of the Boiler Burner Control and UL recognized as a limit control.
  - e. Outlet water supply sensing probe for operating water limit setpoint.
  - f. Return water-sensing probe for operating water limit setpoint.
6. Boiler Controls
- a. The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.
  - b. Controller shall provide for both flame safeguard and boiler control through separate power supplied CPU's (to meet NFPA) and shall perform the following functions:
    - 1) Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition, and post purge. Flame rod to prove combustion.
    - 2) Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent six faults. The control shall be connected to a keyboard display module that will retrieve this information.
    - 3) Safety Shutdown with display of error.
    - 4) Modulating control of the variable speed fan for fuel/air input relative to load requirements.
    - 5) Gas pressure supervision, high and low.
    - 6) Combustion Air Proving Supervision.

- 7) High Air Pressure [back draft too high] Supervision.
  - 8) The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
  - 9) Controller shall be equipped with a touch screen display for set up, trouble shooting, and operational display, and shall include ModBus communication capability of this information.
  - 10) Include the programming of individual boiler system circulating pump and provide the programming of 2 heating loops.
- c. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
  - d. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements.
  - e. Electrical power supply shall be 208/230/3/60. An internal control circuit transformer shall provide 115/1/60 voltage for control circuit requirements.
  - f. A system integration control shall be provided to stage the four (4) boilers. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority and a system digital display. The control shall force each boiler to a lower fire, before allowing any boiler to operate at high fire. This allows for inverse efficiency (lower fire rate, higher efficiency). The control shall monitor supply water temperature, return water temperature and shall communicate between boilers via RS-485 wiring.
7. System Administrator
- a. The boiler room system control shall consist of Systemax 2.0 Network Administrator, to be located within the mechanical equipment room, [3] thermistors for outside air, supply water temperature, return water temperature, and a water flow measuring device. The thermistors shall be field wired to the network administrator along with the flow device. Each boiler within the heating system shall be equipped with an I/O device. Each I/O device shall be hard wired into the boiler control circuit and located at the highest point on the boiler. If system pumps are to be controlled by the Network Administrator, then an I/O device shall be provided for each pair of pumps, and field wired by the installing contractor.
  - b. The Network Administrator shall include a high resolution [320 x 240 pixels] seven inch, graphical user resistive touch screen interface. The touch screen shall be LED back lit and shall be standard screen format [4x3].

c. The Network Administrator shall include the following:

- Ethernet or micro SD card slot for updating/upgrading to new levels of functionality and interactivity.
- Determination of all on/off states of equipment, all output rates of equipment and communicate that data to the individual I/O devices via CAN bus over RS 485 for the purpose of boiler room control and heating operations.
- Through the use of the Graphical User Interface, the Network Administrator shall provide all functionality required for parameterization of the network for system control and shall transmit data to the I/O devices via CAN network for local storage.
- The Network Administrator shall have two RJ45 ports capable of updating/upgrading to new levels of functionality and both capable of ModBus Master/Slave protocols.
- Alarm Output for notification of a boiler/pump/damper failure.
- Capability of individually controlling secondary pumps, with timing off delays for post on cycle purge.
- Capability to individually operate up to ten main system or zone pumps. [System pumps can be individually identified as on, off, or lead lag.]
- Capability of individually operating up to ten combustion make-up air dampers, mechanical combustion air make-up enable circuits, or mechanical draft enable circuits, linked to the firing sequence of the boiler for which it operates.

d. Input/Output [I/O] Devices shall include:

- Two single pole double throw output contacts rated for 8 amps @ 120 VAC.
- Operation at 24 VDC or 120 VAC (120VAC via power supply).
- Each I/O device shall individually communicate confirmation of on/off status, output rate status, and alarm status and heartbeat to the Network Administrator for the purpose of boiler room control and heating operations.

8. Functionality:

The boiler controller shall be capable to individually operate between one [1] and ten [10] boilers with full modulation burners. The control shall have the capability of selectable parallel sequential modulation, and shall provide parallel modulation at any percentage of rated output.

The boiler controller shall be enabled on outdoor air and via contact closure, indicating a call for heat, enable one of three resets for supply temperature; two [2] for winter operation, one [1] for summer operation, allowing changes in building loop temperature based on outdoor air.

Boiler controller shall also be capable of remote enable and remote set point override via external Modbus write commands. Any communication failure shall cause the controller to remain operating and revert to its normally calculated reset schedule.

A warm weather shut down option shall be included.

The boiler controller shall have the capability of individually controlling up to ten [10] boiler output temperatures and the target output temperatures for each boiler can differ one from the other.

The boiler controller shall have the capability of choosing any boiler on the network for operation according to outdoor air temperature, Real Time Load, load predictions, alarm status, minimum output rating, maximum output rating, minimum return temperature, maximum outlet temperature, condensing, non-condensing, winter priority, standby status, hot water priority, efficiency in a given range, and hours of operation.

The boiler controller shall have the capability of calculating the required heating load utilizing supply water temperature, return water temperature, and water flow rate of the main supply header. Based on the load requirement, the control shall assign all or part of any load to a condensing or non-condensing boiler at any outdoor temperature, as required to meet the needs of the system, boiler, and the building. It shall have the capability of overcoming burner output rate tuning issues in order to meet the building load.

The boiler controller shall be able to overcome minimum return temperature errors by increasing boiler output or increasing system supply water setpoint temperature or both. The control shall also have the capability of determining individual maximum output temperatures for each system boiler according to the manufacturers published guidelines.

The control shall be equipped to read both the inlet and outlet temperature of each boiler on the system.

The control shall have the capability to control both boiler inlet temperature and outlet temperature differential [Delta T] of each boiler by sending a modulating signal to a customer supplied pump and appropriately sized frequency drive for this purpose. The control shall adapt to temperature overshoot above the maximum outlet temperature by assigning part of the load to another boiler during boiler delta T operations. As the outlet temperature of a boiler approaches maximum temperature, the boiler controller shall be able to respond by increasing the output signal to the frequency drive attached to the boiler pump in order to reduce boiler delta T and maintain compliance with the manufacturer's published maximum boiler outlet temperature.

The boiler controller shall have the capability to individually operate up to ten (10) main system pumps. All system pumps can be individually identified as on, off, or lead lag. The Network Administrator shall also have the capability of enabling up to (4) system pumps via discrete contacts without the need for a remote I/O device.

The boiler controller shall have the capability of controlling system delta T (temperature) by modulating system pump(s). It shall also be capable of calculating a delta T reset slope.

The boiler controller shall have the capability controlling system delta P (pressure) by modulating system pump(s) speed control to respond to heating system load requirements. It shall also be capable of calculating a delta P reset slope

The boiler controller shall have the capability of an adjustable night and weekend optimum stop/setback of building supply loop temperature. The optimum stop shall allow a gradual setback beginning in advance of unoccupied times through the use of customer input data and collected data.

The control shall have the capability of pre-occupancy system temperature optimum start return and system boost. The optimum start shall allow a gradual return and boost from setback beginning in advance of occupied times through the use of customer input data and collected data. The control shall gradually ramp down loading of boilers from boost setpoint operations.

The boiler controller shall utilize patented "Load Acceleration Control Algorithm" for action required in meeting heating load through an analog signal to the boilers which in turn affect the outputs of the selected boilers.

The boiler controller shall have the capability of a user definable summer reheat mode, reset loop temperature based on outdoor air.

The boiler controller shall have a user definable low fire hold [1 - 60 minutes] time period based on a system differential temperature during low load demands. The controller shall determine if the building is warming up fast enough and if it is, delay release of the boiler to modulation by maintaining low fire to increase efficiency of operation.

The boiler controller shall have freeze protection programming that will overcome heat being disabled in order to protect the building equipment and boilers from the effects of freezing.

The boiler controller shall have the capability for individual boiler alarm inputs that can and will affect whether or not a boiler is available for operational rotation and shall share that information through network traffic.

The boiler controller shall have the capability for individual boiler "prove enabled" inputs that can and set an alarm condition and affect whether or not a boiler is available for operational rotation and shall share this information with the network traffic.

The boiler controller shall have an alarm output on the Administrator device for notification of a boiler failure. There will be two levels of boiler control system alarm:

Low building temperature alarm triggered by low supply temperature set point and a general alarm indicating boiler and/or pump alarms and/or unavailability of boilers and/or pumps.

The boiler controller shall have the capability of selectable parallel, sequential modulation.

The boiler controller shall have the capability of parallel modulation at any percentage of rated output.

The boiler controller shall be able to operate Domestic Hot Water priority and have a physical input to activate this feature. This control function shall allow for temporary set point override to a domestic hot water set point until the demand is satisfied.

Each individual automatically fired hot water boiler shall have a safety limit control that will cut off the fuel supply to prevent water temperature from exceeding the maximum allowable temperature as called out by the manufacturer.

Each individual hot water boiler or each system of commonly connected boilers shall have a control that will cut off the fuel supply when the water temperature reaches an operating limit of 160° F (adj).

9. Field Parameterization

It shall be the boiler manufacturer's authorized field service representation responsibility to ensure that all I/O devices are field programmed for the specific heating load application. Each I/O device will be tested to ensure system network functionality and interface functionality of the Network Administrator and temperature sensors and flow devices that interface with the Administrator. The field service representative shall demonstrate the functionality to the authorized boiler operator and or owner, and demonstrate the method needed to obtain data information.

10. Boiler Flue Venting

- a. The Boiler shall be UL certified as an indirect or direct vent boiler. Venting shall be accomplished with an AL29-4C stainless steel inner wall, and 304 SS outer wall with 1" insulation vent piping installed in accordance with applicable national and local codes. Refer to vent manufacturer's specifications for applicability.
- b. For direct air inlet the boiler shall have the combustion air intake supply ducted with double wall galvanized duct from the outside. Vibration isolation components are not required.

11. Manufacturer's Field Services

- a. General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. A detailed written record of the startup performance, including burner setting data over the entire load range shall be furnished to the engineer before final acceptance. All labor, equipment, and test apparatus shall be furnished by the



authorized service organization. All equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.

- b. Equipment inspection: Boiler representative to provide 4 hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. All shipped loose components, such as casing, to be mounted on boiler by boiler provider after contractor has set boiler in building.
- c. Pre start-up walk through: Boiler representative shall spend 4 hours at jobsite reviewing installation with mechanical contractor to be conducted approximately 1 week prior to startup.
- d. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include:
  - 1) Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
  - 2) Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O<sub>2</sub>, CO, NO<sub>x</sub>, and overall boiler efficiency.
  - 3) Auxiliary Equipment and Accessories: Observe and check all valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non compliance with referenced standards or overloading as applicable.
  - 4) Commissioning Requirements:
    - a) Fireside inspection
    - b) Set up fuel train and combustion air system
    - c) Set up operating set points
    - d) Check all safeties, including Flame safeguard, LWCO, Airflow, Fuel pressures, High limits.
    - e) Set up and verify efficiencies at 20%, 50%, 75%, and 100%
    - f) Set up and verify burner turndown.
- e. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single 4 hour continuous session to accommodate operator's availability on site.

12. Manufacturer: Cleaver Brooks, Buderus, Hydrotherm or approved equal.

## 2.06 CHIMNEYS: DOUBLE WALL FOR CONDENSING BOILERS

1. The double wall flue system shall be an air-insulated double-wall product designed for commercial applications. It shall be approved for use on individual or common vented ANSI Category I, II, III and IV Gas Burning Appliances, Direct Vent and for Gas and Oil fired appliances listed for Type L-Vent applications as approved by the appliance manufacturer.
2. The double wall flue system shall be tested and Listed by Underwriters Laboratories to UL 1 738/ULC S636 for used with Listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550 F. It shall also be tested and Listed by Underwriters Laboratories to UL 641/ULC S609 for use with Listed oil and gas burning equipment that are suitable for venting with Type L vent which produce continuous flue-gas temperatures not above 570 F. The system shall be installed and sealed per manufacturers' instructions so all joints are gas tight, preventing leakage of products of combustion into a building.
3. The double wall flue system shall be a double-wall product that consists of a flue-gas conduit fabricated from AL 29-4C® stainless steel, which is highly suited for use with high-efficiency gas burning equipment, which produce excessive amounts of condensation in the vent. The outer jacket of the system shall be constructed of type 430 stainless steel with a space of approximately 1" between the flue-gas conduit and the jacket.
4. All joints in the double wall flue system shall be fastened with a closure system that combines the features of the manufacturer's tapered ends with a mechanical closure system consisting of tabs and a locking band. The locking band shall be tightened from a single location using a simple hand tool, pulling the two pieces together making a pressure tight assembly. When installed on positive pressure or condensing applications, the joints must be sealed. Diameters 4" through 16" shall be manufactured with a factory adhered seal. Diameters 18" through 32" shall use an approved sealant on the job site. This closure system shall be tested to be gas tight at two and one-half times the listed pressure rating of 15" water column.
5. System shall include all accessories necessary, including roof penetrations, termination screen, rain cap, guy wires and anchors, thimbles, supports, flanges, adjustable sections, etc. Manufacturer shall include accessories and assemblies as required to complete the flue gas system.
6. When properly installed the double wall flue system may safely and securely be utilized in either interior or exterior installations. The system shall be capable of withstanding reasonable wind and incidental loads as required by UL standards.
7. When connected to gas-burning appliances with a maximum continuous flue-gas temperature of 550 F, 4" through 24" diameter double wall flue system can be fully enclosed vertically by combustible materials at 1" or greater clearance and 26"-32" diameter by 2" or greater clearance. For Oil fired Type L-Vent with a maximum flue-gas temperature of 570, 4" through 8" diameter a fully enclosed system requires 3" clearance. For horizontal applications refer to the manufacturer's Clearance Chart.
8. The double wall flue system shall be sized in accordance with appliance manufacturers'

specifications, the most current edition of NFPA 211 Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, the most current edition of NFPA 54 National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and all applicable local and regional codes. This proper sizing, based on information supplied by the consumer, shall be reflected in scale drawings of the system provided by the manufacturer.

9. The double wall flue system is to be installed only in accordance with the manufacturer's "Installation and Maintenance Instructions" and with all applicable local, regional, and national codes.
10. Submittals shall include detailed plan and elevation drawings of the chimney system, indicating specific components and configuration with respect to the building. Included in the submittals shall be draft calculations performed by the chimney manufacturer to verify that the chimney system will provide adequate draft when the specified equipment is in operation.
11. Model/Manufacturer: Saf-T Vent CI Plus Special Gas Vent by Heatfab Inc.

**2.07 COMBUSTION AIR INTAKE for CONDENSING BOILERS: METALBESTOS - AIR GAP**

1. Double wall pre-fabricated metal chimney with 1" minimum insulating air gap between inner and outer pipe. Inner pipe shall be minimum 0.035" Type 316 stainless steel with flanged ends. Flanged connections to be sealed with RTV silicone and secured with Type 316 stainless steel fasteners. Outer pipe to be minimum 0.025" thick aluminized steel protected by minimum one coat each heat and corrosion resistant primer and paint. Outer pipe exposed to weather shall be minimum 0.035" Type 316 stainless steel.
2. Chimney system to be UL listed for the application and shall include fittings, caps, supports, thimbles and accessories as required. Base of stack shall be provided with drain section, piped to floor drain with drain valve.
3. Submittals shall include detailed plan and elevation drawings of the chimney system, indicating specific components and configuration with respect to the building.
4. Combustion air intake system to be Metalbestos Type "PS".

**2.08 CHIMNEYS FOR PLUMBING SHOP BOILERS: METALBESTOS - AIR GAP**

1. Double wall pre-fabricated metal chimney with 1" minimum insulating air gap between inner and outer pipe. Inner pipe shall be minimum 0.035" Type 316 stainless steel with flanged ends. Flanged connections to be sealed with RTV silicone and secured with Type 316 stainless steel fasteners. Outer pipe to be minimum 0.025" thick aluminized steel protected by minimum one coat each heat and corrosion resistant primer and paint. Outer pipe exposed to weather shall be minimum 0.035" Type 316 stainless steel.
2. Chimney system to be UL listed for the application and shall include fittings, caps, supports, thimbles and accessories as required. Base of stack shall be provided with drain section, piped to floor drain with drain valve.

3. Submittals shall include detailed plan and elevation drawings of the chimney system, indicating specific components and configuration with respect to the building.
4. Chimney to be Metalbestos Type "PS".

### PART 3 - EXECUTION

#### 3.01 GENERAL

1. Install equipment in accordance with the manufacturer's recommendations.

#### 3.02 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 18 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required for maintenance during the Warranty period.

#### 3.03 MAINTENANCE

3. The contractor shall maintain the new boilers during the project. The maintenance shall be in accordance with section 3.02 of this specification section and the manufacturer's recommendations. The contractor shall furnish and install parts and labor during the project at no additional cost to the owner.
4. The contractor shall maintain the existing boiler equipment until the project completes the last phase of construction. Refer to the phasing documents for project duration. The maintenance shall be in accordance with section 3.2 of this specification section and the manufacturer's recommendations. The contractor shall furnish and install the required maintenance of the equipment, including parts and labor, at no additional cost to the owner.
5. The maintenance shall include but not be limited to monthly greasing, equipment checks, phasing test for the addition of new equipment and piping, and cleaning.

END OF SECTION

SECTION 23 60 00 - REFRIGERATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training.
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of section 230000, General Provisions, and with the provisions of all applicable codes and laws.
2. The installation and equipment is to conform to ANSI B 9.1 Safety Code for Mechanical Refrigeration.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Chillers
  - b. Cooling Towers
  - c. Air Cooled Condensers
  - d. Refrigeration Accessories
  - e. Field Performance Tests
3. System maintenance requirements not covered by equipment manufacturers' instructions.

1.04 SYSTEM TESTING

1. Perform operating tests and instruct Owner's personnel as specified in Section 230000. Produce and maintain refrigeration effect under operating criteria determined in advance by agreement with the Architect and the Building Official.

**PART 2 - PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

1. Construct all apparatus of materials suitable for the conditions encountered during operation.
2. Construct all equipment in accordance with the requirements of the local and state codes. Construct all pressure vessels in accordance with the ASME Code for unfired pressure vessels. Pressure vessels shall bear the code stamp.
3. All factory applied acoustical and thermal insulation, including facing and adhesive, to be fire-resistant or non-combustible, and shall conform to the requirements of NFPA and local codes.
4. Mount grease fittings directly on bearings unless the bearings are not visible or inaccessible. Then provide easily accessible extensions to bearing lubrication fittings.
5. Balance all fan wheels and other moving components statically and dynamically. Drill all fan shafts on the center line to receive a tachometer point.
6. Match and balance all system components to achieve compatibility of equipment for satisfactory operation and performance throughout the entire operating temperature and control range.
7. Provide all controls, wiring, piping, valves, tubing, accessories and other components necessary to make a complete operating system.
8. All refrigeration equipment shall comply with the applicable provisions of the ASME Code and American Standard Safety Code for Mechanical Refrigeration ASA-B 9.1, the requirements of all regulating bodies having jurisdiction and the recommendations of the equipment manufacturer.
9. Electrical operating and safety controls shall be 120 volt or less. The control circuit shall have a grounded neutral with all safety controls in the ungrounded leg.
10. All items of refrigeration equipment shall be shipped complete with a holding charge or refrigerant and oil.
11. Chillers shall be shipped with a factory charge of refrigerant HCFC-123 or R-134a. Chillers using R-11 or R-12 shall not be acceptable.

2.02 CHILLER: HIGH EFFICIENCY CENTRIFUGAL

1. Performance Tolerance And Verification Of Chiller Capacity And Efficiency

a. Factory Performance Test

- 1) The chiller test points shall be an ARI 4 Point test as follows: 100% @ 85F ECWT and design condenser water flow, 75% at 75 ECWT, 50% and 25% @ 65F ECWT.

\* Adjustments to be made per paragraph C6.3 of ARI Std 550/590-2003

- 2) A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company.
- 3) The equipment will be accepted if the test is conducted in conformance with ARI Standard 550/590-2003 procedures and the proposed tolerances are met.
- 4) If the equipment fails to perform within proposed tolerances, the manufacturer will be allowed to make necessary revisions to his equipment and retest as required.
- 5) In the event that these revisions do not achieve submitted performance, the following penalties will be imposed:
  - a) **CAPACITY TEST:** For each ton below the allowable capacity, one thousand dollars per ton will be deducted from the contract price.
  - b) Allowable capacity = [(1 - tolerance) x design capacity]
  - c) **POWER CONSUMPTION PENALTY:** All load points and the Power Consumption Penalty (P.C.P.) shall be based upon the tolerances specified above. The P.C.P shall be calculated based upon the following formula: P.C.P. = [Measured KW - (Measured Tons x ALLOWABLE KW/Ton\*)] x \$2000/KW \*Allowable KW/Ton = [(1 + tolerance) x design KW/Ton]
  - d) **TOTAL PERFORMANCE PENALTY:** The total performance penalty will be the sum of CAPACITY PENALTY AND POWER CONSUMPTION PENALTY, times the number of typical chillers, regardless if tested.
  - e) Equipment manufacturer shall not invoice for the centrifugal chillers(s) until successful completion of the performance test or acceptance of penalty deduction from the contract.

- b. All Chillers shall be factory performance tested with the proposed refrigerant under full load and part load conditions in an ARI certified test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper ARI certification documents for the test loop shall be made available upon request from the manufacturer for inspection.
- c. The factory test instrumentation shall be per ARI Standard 550/590-2003, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (formerly NBS).
- d. The performance test shall be run with clean tubes in accordance with ARI 550/590-2003 to include the following:
  - 1) A downward temperature adjustment per ARI 550/590-2003 Section C6.3 shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
  - 2) An upward temperature adjustment per ARI 550/590-2003 Section C6.3 shall be made to the design entering condenser water temperature to adjust from the design fouling to the clean tube condition.
  - 3) There shall be no exceptions to conducting the performance test with clean tubes and with temperature adjustments in (1) and (2). The manufacturer shall clean tubes, if necessary, prior to test to obtain a test fouling factor of .0000 hr. sq. ft. F/BTU.

2. Regulatory Requirements

- a. Conform to ARI Standard 550/590-2003 code for rating and testing of water chillers.
- b. Conform to UL 1995 for Safety for Heating and Cooling Equipment.
- c. Conform to ANSI/ASME SECTION VIII Boiler and Pressure Vessel Code for construction and testing of centrifugal chillers as applicable.
- d. Conform to ANSI/ASHRAE STANDARD 15-2001 code for construction and operation of centrifugal chillers.
- e. Unit shall bear the ARI Certification Label for the specific type of water chiller as applicable.

3. Handling And Equipment Room Requirements

- a. Comply with manufacturer's installation instructions for rigging, chiller loading, local transportation requirements, unloading, storage, rigging and final setting.



- b. Protect chiller and controls from physical damage. Leave factory shipping covers in place until installation.
- c. Equipment Room Requirements
  - 1) Follow minimum standards for refrigeration systems as required by ANSI/ASHRAE Standard 15-2001 paying special attention to requirements for air monitoring, ventilation, self-contained breathing apparatus and leak detection to assure the safety of chiller plant operating personnel.
  - 2) Install proper outside exhaust of chiller refrigerant relief device(s), discharge header(s), and purge unit(s). Route exhaust to the outside of the building and away from all air intakes in compliance with ANSI/ASHRAE Standard 15-2001.
  - 3) Install a refrigerant monitor that can be calibrated for appropriate refrigerant(s), capable of detecting concentrations of minimum ppm for low level leak detection to assure the safety of chiller plant operating personnel.
  - 4) Install suitable audible and visual alarms that activate well below the Acceptable Exposure Level (AEL) of the specific refrigerant(s) to alert persons inside and outside of the equipment room that a refrigerant leak condition exists.

4. Summary

- a. Description: Factory-assembled and tested water chiller complete with compressor, evaporator, condenser, controls, starter or variable speed drive, interconnecting unit piping and wiring, indicating accessories, and mounting frame. Performance shall be per specification section 3 schedule.
- b. The contractor shall furnish and install centrifugal water chillers as shown and scheduled in the plans and specifications. The units shall produce the specified tonnage per the scheduled data in accordance with ARI 550/590-2003. The unit shall bear the ARI certification label as applicable.
- c. Unit shall be painted in accordance with the manufacturers standard procedures and practices.

5. Compressor And Motor

- a. The compressor shall be centrifugal.
- b. Low pressure refrigerant machines shall be provided when available.

- c. Chiller should be able to unload to 20 percent of design tonnage with constant 85F entering water temperature. The minimum unloading point shall be demonstrated at the time of the factory performance test. The machine shall be modified to include hot gas bypass if the minimum load cannot be met.
  - d. Compressor assembly shall be vibration tested at the factory. Vibration shall not exceed 0.15 inches per second. The test data shall be recorded and provided to the customer for approval.
  - e. The motor shall be hermetic and either suction or liquid refrigerant cooled. Hot gas motor cooling is not acceptable. If an open drive motor is provided, a motor-compressor shaft seal leakage containment system shall be provided.
    - 1) An oil reservoir shall collect any oil and refrigerant that leaks past the seal.
    - 2) A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.
    - 3) Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the chiller for a period of 5 years from initial start-up, including parts and labor to replace a defective seal and any refrigerant required to trim the charge to original specifications. Inspections shall be performed a minimum of once a year.
    - 4) Motors shall have winding RTD's for temperature sensing on each phase. These temperatures shall be furnished to the unit control panel for monitoring and alarm.
  - f. Manufacturers with speed increasing transmissions shall not exceed 10,000 RPM compressor speeds and shall annually inspect the gears and all bearings. A report shall be forwarded to the owner each year over the first five years to confirm completion.
  - g. The impellers shall be fully shrouded and made of a high strength aluminum alloy. Impellers shall be dynamically balanced and over-speed tested at 1.25 times impeller shaft speed.
6. Evaporator (Chiller Barrel)
- a. The evaporator and condenser shall be built in accordance with ANSI/ASHRAE 15-2001 Safety Code for Mechanical Refrigeration.
  - b. Evaporator tubes shall be internally enhanced. The minimum tube wall thickness shall be 0.025 inch.
  - c. The evaporator water piping connections shall be victallic.

- d. The evaporator water boxes shall be standard non-marine type with connections per schedule.
  - e. Supply and return head water boxes shall be designed for a working pressure of 150 psig and shall be factory hydrostatic pressure tested at 150 percent of the design pressure. Provide drain and vent connections in water boxes.
  - f. Insulation will be 3/4" insulation and cover all low temperature surfaces to include the evaporator, water boxes, and suction elbow. Economizer, if applicable, is insulated with 3/8" insulation.
  - g. Units with multi-stage compressors shall incorporate an interstage flash vessel "economizer". All units with single stage compressors shall have the condensers circuited for liquid subcooling and be provided with a thermometer well to monitor the amount of subcooling.
  - h. Adjustable or float type refrigerant metering devices and thermal expansion valves shall be inspected and adjusted by the manufacturer at the end of each year for the first five years of operation to assure equivalent reliability and maintenance to a fixed orifice system. A written report shall be forwarded to the owner each year to confirm completion.
7. Condenser
- a. The condenser shall be built in accordance with ANSI/ASHRAE 15-2001 Safety Code for Mechanical Refrigeration.
  - b. Condenser tubes shall be internally enhanced. The minimum tube wall thickness shall be 0.028 inch.
  - c. The condenser water piping connections shall be victallic.
  - d. The condenser water boxes shall be standard non-marine type with connections per schedule.
  - e. Supply and return head water boxes shall be designed for a working pressure of 150 psig and shall be factory hydrostatic pressure tested at 150 percent of the design pressure. Provide drain and vent connections in water boxes.
8. Purge System
- a. The manufacturers of low pressure machines, must provide a purge system.
  - b. The purge efficiency must meet ASHRAE Standard 147-2002 paragraph 4.7.
  - c. The purge shall be capable of operating when the chiller is idle in accordance with ASHRAE Standard 147-2002, paragraph 4.7.2 (a). If the purge unit cannot operate when the chiller and pump are off, a positive pressure device (such as a

belly heater) shall be provided to prevent non-condensables from entering the machine per ASHRAE Standard 147-2002, paragraph 4.7.2 (b). This will raise the pressure in the evaporator bundle above atmospheric pressure when the machine is off.

9. Controls
- a. The chiller shall be controlled by a unit mounted, stand-alone Direct Digital Control (DDC) system. A dedicated chiller microprocessor control panel is to be supplied with each chiller by the chiller manufacturer.
  - b. Enclosure shall be unit mounted NEMA 250 Type 1 using wire duct. Zip ties are not acceptable.
  - c. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 12.1" diagonal. The display shall be fully adjustable in height and viewing angle. Animated graphical representations of chiller subsystem operation shall be used to enhance the user interface.
  - d. Display shall consist of a menu driven interface with easy touch screen navigation to organized subsystem reports for compressor, evaporator, condenser, purge and motor information as well as associated diagnostics. The controller shall display all active diagnostics and a minimum of 20 historical diagnostics.
  - e. The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator must be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.
  - f. The chiller control panel shall provide control of chiller operation and monitoring of chiller modules, sensors, actuators, relays and switches. The chiller control panel shall include controls to safely and efficiently operate the chiller.
  - g. Safeties - the chiller control panel shall provide the following safeties:
    - 1) Low chilled water temperature
    - 2) Low evaporator refrigerant temperature or pressure
    - 3) High condenser refrigerant pressure
    - 4) Evaporator and condenser water flow status
    - 5) Low oil pressure

- 6) Low oil temperature
- 7) High oil temperature
- 8) High motor winding temperatures
- 9) High motor current
- 10) Starter/AFD function faults
- 11) Sensor faults
- 12) Unit controls operation
- 13) The chiller control panel or starter shall incorporate advanced motor protection to safeguard the motor throughout the starting and running cycles from the adverse effects of:
  - a) Current phase loss
  - b) Current phase unbalance
  - c) Current phase reversal
  - d) Under/Over voltage
  - e) Motor current overload
  - f) Distribution fault protection with auto restart consisting of three-phase current sensing devices that monitor the status of the current
  - g) Starter contactor fault protection
  - h) Starter transition failure
- h. The chiller control panel shall be capable of displaying system data in I-P or SI units.
- i. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
  - 1) Run time
  - 2) Number of starts
  - 3) Current chiller operating mode
  - 4) Chilled water set point and set point source

- 5) Electrical current limit set point and set point source
  - 6) Entering and leaving evaporator water temperatures
  - 7) Entering and leaving condenser water temperatures
  - 8) Saturated evaporator and condenser refrigerant temperatures
  - 9) Evaporator and condenser refrigerant pressure
  - 10) Oil tank temperature
  - 11) Oil tank pressure
  - 12) Oil pump discharge pressure
  - 13) Differential oil pressure
  - 14) Compressor motor current per phase
  - 15) Compressor motor percent RLA
  - 16) Compressor motor voltage per phase
  - 17) kW energy consumption and power factor
  - 18) Compressor motor winding temperatures per phase
  - 19) Purge operating mode
  - 20) Purge operating status
  - 21) Time until next purge run
  - 22) Daily pumpout - 24 hours
  - 23) Avg daily pumpout - 7 Days
  - 24) Purge refrigerant compressor suction temp
  - 25) Purge liquid temp (chiller condenser saturated refrigerant temperature)
  - 26) Daily pumpout limit/alarm
- j. The chiller control panel shall provide password protection of all setpoints.

- k. Control authority must be capable of handling at least four conditions: Off, local manual at the chiller, local automatic at the chiller and automatic control through a remote source.
- l. The chiller control panel shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.
- m. The chiller control panel shall provide individual relay outputs to start/stop the evaporator and condenser water pumps. The condenser water pump relay output can be used to enable the cooling tower temperature controls.
- n. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
- o. The chiller control panel shall be capable of providing short cycling protection.
- p. The chiller control panel shall provide a relay output that shall energize whenever the compressor is running.
- q. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
- r. The chiller control panel shall provide a relay output that shall energize whenever the chiller is operating at maximum capacity.
- s. The chiller control panel shall provide a head relief request relay output to indicate that the chiller is in condenser limit mode and thereby requesting condenser water temperature relief.
- t. The chiller control panel shall provide an analog output signal that shall indicate the Compressor Motor Percent RLA.
- u. The chiller control panel shall provide an analog output signal that shall indicate the condenser refrigerant pressure or condenser/evaporator differential refrigerant pressure.
- v. The chiller control panel shall provide condenser limit control including a pressure transducer and interconnecting piping and wiring. This control shall be used to avoid high condenser refrigerant pressure tripouts. The control shall take action in response to the condenser refrigerant pressure. Whenever this control is in effect, the panel will automatically indicate that the chiller is in adaptive mode and if the condition exists for more than 30 seconds, a limit warning alarm shall energize.

10. Starters

a. Variable Speed Drive (VSD), Unit Mounted

- 1) The centrifugal water chiller shall be furnished with a liquid cooled variable speed drive (VSD) as shown on the drawings. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.
- 2) The VSD will be specifically designed to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed and compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If a surge is detected, VSD surge avoidance logic will make adjustments to move away from and avoid surge at similar conditions in the future.
- 3) The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96.
- 4) The VSD shall be solid state, microprocessor based pulse width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBT transistors.
- 5) Power semi-conductor and capacitor cooling shall be from a liquid cooled heatsink.
- 6) The VSDs shall each be furnished in a NEMA 1 metal enclosure having as minimum a short circuit withstand rating of 65,000 amps per UL 508. It will include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and all components properly segregated and completely enclosed in a single metal enclosure.
  - a) Enclosure shall include a padlockable, door-mounted circuit breaker with shunt trip and AIC rating of 65,000 amps.
  - b) The entire chiller package shall be U.L./C.U.L. listed.
- 7) The VSD shall be tested to ANSI/UL Standard 508 and shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as designated by OSHA.
- 8) Compliance to recommendations stated in IEEE 519-1992.
  - a) The VSD design shall include as standard integrated active rectification control system to limit total demand distortion (TDD) in current at the VSD to less than or equal to 5-percent. If active filters are used to meet



less than or equal to 5% TDD, then the losses associated with the filter shall be included in the chiller performance on the selection.

- 9) Input shall be nominal 480 volts, three phase, 60 Hertz AC power, +/- 10 percent of nominal voltage.
- 10) Line frequency 38-60 hertz.
- 11) The VSD shall include the following features:
  - a) All control circuit voltages are physically and electrically isolated from power circuit voltage.
  - b) One hundred fifty percent instantaneous torque available for improved surge control.
  - c) Minimum and maximum speed adjustments.
  - d) Soft start, adjustable linear acceleration, coast to stop.
  - e) Adjustable current limiting and UL approved electronic motor overload protection.
  - f) Insensitivity to incoming power phase sequence.
  - g) VSD and motor protection from the following faults: - Output line-to-line short circuit protection - Line-to-ground short circuit protection - Phase loss at AFD input - Phase reversal / Imbalance - Over-voltage - Under-voltage - Over temperature
  - h) Carrier frequency shall be fixed at 4 Khz for maximum efficiency.
- 12) The following VSD status indicators shall be available to facilitate startup and maintenance: - Output speed in hertz and rpm - Input line voltage - Input line kW - Output/load amps - Average current in percent RLA - Load power factor - Fault - VSD transistor temperature
- 13) Service Conditions - at full output power. No external venting or heat exchangers shall be required.
  - a) Operating ambient temperature 32-104 F (0-40 C).
  - b) Room ambient 0-95% relative humidity.
  - c) Elevation to 3300-feet (1000-meters). For every 300-feet above 3300-feet, the rated output current shall be decreased by one percent.

11.     Manufacturer:                             Model:  
          Trane                                     CVHE  
          Carrier  
          York

2.06    COOLING TOWER: CENTRIFUGAL - BLOW THROUGH - CORROSION PROTECTED

1.     A complete factory assembled unit of matched components including belt driven centrifugal fan and drives, wet deck, pan, casing, eliminators, all necessary piping, wiring, controls and accessories. All tower materials of construction shall be hot dipped galvanized steel unless otherwise noted.
2.     Pan shall be V-shaped heavy gauge, type 304 stainless steel with type 304 steel reinforcing angles. Circular gasketed access doors located at both ends of the pan section. Type 304 steel anticavitation plate.
3.     Galvanized steel forwardly curved centrifugal belt driven fans with four sided discharge cowls. Heavy duty pillow block type bearings with eccentric locking collars and extended lube lines, and grease fittings. Multiple, adjustable, vee belt type for drives designed for not less than 150% of nameplate horsepower. Galvanized steel protective fan inlet screens. Fan motors shall be totally enclosed, fan cooled (TEFC), squirrel cage, ball bearing type suitable for outdoor service. Fan motors shall be suitable for variable frequency drives.
4.     Wet deck - wave formed, self-extinguishing, polyvinyl chloride, minimum 15 mils thick, with a maximum flame spread rating of 5.
5.     Eliminators - Hot dipped PVC eliminator plates with a minimum of three directional changes. Individually removable. Eliminator sections shall not exceed 100 pounds in weight per section.
6.     Water circulation system - multiple steel distribution headers with removable PVC spray nozzles running the entire length of the heat exchanger section.
7.     Wiring diagrams - provide one set of complete reproducible power and control wiring diagrams, clearly indicating factory and field wiring. Submit one set of marked up shop-drawings to the division 17 contractor upon receipt of Engineer's approval.
8.     Accessories.
  - a.     Factory installed submersible electric immersion heater(s), sump thermostat with sensing bulb, float switch, power contactors and heater fused disconnect switch, each in NEMA 3R waterproof enclosures.
  - b.     Solid brass float-type make up water valve with foam filled ball.

9. Sound absorbers.
  - a. Factory constructed inlet and outlet attenuators, outer casing of 22 gauge galvanized steel, lock formed seams, mastic filled. 26 gauge perforated galvanized steel interior partitions.
  - b. Filler material of inorganic glass fiber, packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be insect and vermin, and moisture proof. Fill shall conform to ASTM and NFPA regulations governing flamespread, smoke development, and fuel contribution.
  - c. Seal joints airtight in the field.
  - d. Mating flanges for connection to equipment.
  - e. Submit certification of acoustical performance from an independent testing laboratory.
  
10. Manufacturer:                      Model/Series:  
    Baltimore Aircoil                  VTL (low profile)  
    Evapco                                LRT  
    Recold                                 JT

2.15 AIR CONDITIONING UNIT – SPLIT-SYSTEM COOLING ONLY INDOOR UNITS

1. Complete assembly including cooling coil, fan, fan motor, all necessary accessories and controls, interconnecting piping, valves and wiring assembled within a finished cabinet.
2. General: Indoor, direct-expansion, ceiling-suspended fan coil. Fan coil shall be hipped complete with cooling coil, fan, an motor, piping connectors and ceiling mounting brackets.
3. Unit Cabinet: Indoor cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting brackets shall be provided.
4. Fans: Indoor fan shall be 3-speed centrifugal blower type with air intake in the bottom rear of the unit and discharge in the front. Automatic, motor-driven vertical air sweep shall be provided standard.
5. Coils: Indoor coils shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate.
6. Motors: Motors shall be permanently lubricated ball bearing with inherent overload protection.
7. Controls: Controls shall consist of a solid state thermostat control system which shall control space temperature and determine optimum fan speed. The unit shall have the following functions as a minimum.

- a. An automatic restart after power failure at the same operating conditions as at failure.
  - b. Thermostat control to enter set points and operating conditions.
  - c. Filter status indication after 250 hours of indoor fan operation.
  - d. Cooling mode to provide modulating fan speed based on difference between temperature based on difference between temperature setpoint and space temperature.
  - e. Fan only operation to provide room air circulation when no cooling is required.
  - f. Fan speed control shall be user-selectable: high, medium, low or automatic operation during all operating modes.
  - g. A time delay shall prevent compressor restart in less than 2 or 4 minutes (adjustable).
8. Filters: Unit shall have filter track with factory-supplied cleanable filters.
  9. Electrical Requirements: Unit shall operate on 208/230 v 60 Hz power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.
  10. Unit shall be matched with condensing unit by the same manufacturer.
  11. Units to be provided with an auxiliary drip pan underneath the unit with an overflow shut-off switch.
  12. Carrier Corporation Model 40QAB or the approved equal of Trane, York.

#### 2.16 CONDENSING UNIT – SPLIT SYSTEM OUTDOOR

1. General: Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of R-22 refrigerant and special features required prior to field start-up.
2. Unit Cabinet: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish. Removable access panels for full access to the compressor, fan and control components.
3. Fans:
  - a. Direct-drive propeller type fans. Fan motors totally enclosed; single-phase; permanently lubricated sleeve bearings, with internal thermal overload protection.
  - b. Shaft shall have inherent corrosion resistance. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced. Provide PVC coated protection grille over fan and coil.

4. Compressor:
  - a. Compressor shall be fully scroll type, equipped with oil system, operating oil charge and motor. Internal overloads shall protect the compressor from overtemperature, overcurrent. Discharge gas temperature protection if required.
  - b. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
  - c. Compressor assembly shall be installed on rubber vibration isolators and shall have internal spring isolation.
5. Outdoor coil: Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated and sealed.
6. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gauge port connections, suction line service valve with service gauge connection port, service gauge connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, pressure relief and a full charge of refrigerant.
7. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled and tested. The minimum control functions shall include the following:
  - a. Controls:
    - 1) Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    - 2) Automatic restart on power failure.
    - 3) Safety lockout if any outdoor unit safety is open.
    - 4) A time delay control sequence provided through the fan coil board, thermostat, or controller.
    - 5) High-pressure and liquid line low-pressure switches.
    - 6) Automatic outdoor-fan motor protection.
    - 7) Start capacitor and relay (single-phase units without scroll compressors).
  - b. Safeties:
    - 1) System diagnostics.
    - 2) Compressor motor current and temperature overload protection.
    - 3) High-pressure relief.
    - 4) Outdoor fan failure protection.
8. Casing: Aluminum or galvanized steel with baked enamel finish, galvanized steel angle legs.

9. Low ambient control
- a. Low ambient kit: Shall regulate fan-motor cycles in response to saturated condensing, pressure of the unit. The control shall be capable of maintaining a condensing temperature of  $100^{\circ}\text{F} \pm 10^{\circ}\text{F}$ . Installations of kit shall not require changing the outdoor-fan motor.
  - b. Winter start control: Field supplied and installed winter start control shall permit start-up for cooling operation under low-load conditions and at low-ambient temperatures by bypassing the low-pressure switch for a 3-minute delay period.
  - c. Crankcase heater: Unit shall be shipped with a clamp-on compressor oil sump heater.
10. Unit shall be matched with indoor cooling unit by the same manufacturer.
11. Manufacturer: Model:  
Carrier 38 HDC  
or the pre-approved equal of Trane, York

2.17 REFRIGERATION VALVES AND ACCESSORIES

- 1. Provide all necessary valves and accessories of adequate capacity and pressure rating to make a complete operable system. Connection shall be at least the full size of the connecting piping.
- 2. Charging valves: Henry Valve Co., Type 623 or 643.
- 3. Magnetic Stop Valve: Alco Valve Co., Series S, M, and R.
- 4. Relief Valves: Henry Valve Co. No. 52 or 54.
- 5. Sight Glasses: Henry Valve Co. Type L1-35.
- 6. Strainers: Alco Valve Co. No. 922.
- 7. Dehydrator: Henry Valve Co. Type 7-C.
- 8. Stop Valves: Henry Valve Co. Type 203.
- 9. Thermal Expansion Valves: with external bulb and equalizer, Alco Valve Co. - T Series.

2.18 REFRIGERANT GAS DETECTION SYSTEM

1. General

- a. Refrigerant gas detection system supplier/installer shall be familiar with standard practices of safety and installation of refrigerant gas vapor detection systems and shall provide these systems as a normal course of business. Acceptable gas detection supplier shall supply a list of 12 similar projects. Acceptable suppliers:
- b. Manufacturers: OI Analytical Corporation, Honeywell Sensing, Kunding, ATC, Inc or approved equal.
- c. System shall be "Packaged Equipment."
- d. System shall meet or exceed the latest ASHRAE 15-2001 requirement and EPA standard 608 CFR. System shall incorporate all latest revisions to bring up to current standards.
- e. Refrigerant gas detection system shall comply with IMC 2003 and/or all local codes.

2. Gas Detection System

- a. System shall be capable of detecting presence of any CFC, HCFC, or HFC refrigerant regardless of which chiller is selected (i.e. R-22, R-123, R-134a, R-410, etc. or other). System shall be capable of indicating, alarming, and shutting down equipment as specified below and in governing regulations. Oxygen deficiency monitoring shall not be acceptable in lieu of LTV-TWA monitoring for human safety exposure. Where combustion equipment is employed, refrigerant vapor monitoring system shall automatically shut down the combustion process in event of refrigerant leakage if other alternative acceptable conditions are not applied. Sequential sampling and multi-point monitoring shall be employed where air flow currents and room size prohibit a representative sample from one sensing point. Diluted samples due to ventilation air flow currents shall employ multi-point monitoring techniques strategically located according to regulation guidelines. Multiple chiller applications shall carefully consider whether mechanical room size and layout can adequately be monitored to comply with regulations with a single point or a multi-point system. System design considerations shall also be incorporated in leak detection monitoring sensing location(s), for early warning indication to prevent a major loss of refrigerant without alarm, should a leak occur.

3. Control Panel and Control Panel Equipment

- a. Analyzer: Analyzer shall be microprocessor-based and employed infrared (IR) sensor technology. It will accurately provide sensing down to one part per million (ppm) and shall be compound specific and/or monitor multiple compounds as specified, and be calibrated for either refrigerant R-22, R-123, R-134a, R-410, or other as required by approved chiller system. Any installed unit can be switched to monitor, at a future date, to another refrigerant type of changing one part and recalibrating (i.e. CFC-11 to HCFC-123, etc.). Adjustable three level alarm for

each point shall be supplied with common alarm output contacts. Provide local digital indication of ppm level for four sample points. Alarms shall be identified by an alarm message indicating the point in alarm and the alarm level. Unit shall have self diagnostics, and supply a common malfunction output for alarm horn or beacon. Loss of sample flow at either sample or ZERO line will indicate system malfunction.

- b. Sequential Sampling System: Four point sequential sampling system shall be integrated into one analyzer enclosure. Microprocessor shall sequentially control required flow valves and communicated output signals to allow monitoring from multiple remote sampling locations. Unit shall read and hold output value of infrared sensor and control of corresponding four point sequential sampling assembly. Each sampling point shall have adjustable sampling tie and adjustable levels of alarm. Sample line capability up to 500 ft. The system shall have add-on sample point expansion modules available for present configuration and future expansion.
- c. The system shall monitor and display accurately with the range of 0 to 25 ppm for refrigerant system and chiller diagnostics, detecting low level refrigerant leads and deterioration of system efficiency.
- d. NEMA-4 wall mount enclosure. Auto zero calibration shall be initiated at one hour interval (adjustable) or manually at the monitor and shall automatically zero by drawing air from an uncontaminated air source. Include built-in sample pump and differential pressure flow switch for low flow indication. Provide four separate 4-20 mA dc analog outputs and one RS-485 output of refrigerant level(s) for input into Direct Digital Control (DDC) or Building Management System (BMS). Unit shall be insensitive to vibration and shall provide for a continuous sample. Intermittent dump and purge, batch type samples with long response times shall not be acceptable. Response time shall be twenty (20) seconds or less to ninety-nine (99%) percent of reading. Malfunction relay is energized due to flow loss or electrical malfunction. Electrochemical sensing technology employing depletion sensors and short term life sensors, which deplete as a normal part of their operation or storage shelf life, shall not be acceptable.
- e. The system shall be configured to provide for an optional relay board, with dry contacts for each channel, to initiate output signal for three level alarms at local panel, interface with both the DDC or BMS and the building ventilation system. An early leak warning alarm shall be set at 10 ppm, regardless of refrigerant type, to prevent large refrigerant loss and provide chiller diagnostics. Other alarm level shall be set at or below the TLV-TWA level of ppm (e.g. 30 ppm for R-123). At the TLV-TWA level the system shall activate the purge ventilation system and sound a refrigerant leak alarm. Malfunction alarm indication and horn shall be provided (by contractor). Provide dry alarm contacts for each alarm level for interface to the DDC or BMS.
- f. Installation: Unit must be factory calibrated. No field calibration is acceptable at time of installation.



- g. Maintenance & Calibration: No calibration shall be required for a period of one (1) year from date of shipment. Zero filter and end of line filters should be replaced every three to six months or sooner, based on usage.

### PART 3 - EXECUTION

#### 3.01 GENERAL

- 1. Install equipment in conformance with manufacturer's recommendations.

#### 3.02 FIELD TESTS - PERFORMANCE

- 1. The manufacturer of the equipment shall perform all field testing and final adjustment of the refrigeration apparatus in accordance with provisions of the applicable ASHRAE Standards and 2003 IMC Section 1108.
- 2. Compile and certify the following data as applicable to the equipment being tested.
  - Outdoor air temperature
  - Temperature of chilled water - in and out
  - Temperature of condenser water (or glycol) - in and out
  - Chilled water flow - GPM
  - Condenser water (or glycol) flow - GPM
  - Pressure drop through chillers
  - Pressure drop through condensers
  - Condensing temperature
  - Operating kilowatts from measured voltage, amperes, power factor.
- 3. Should any part of the apparatus or system fail to meet the contract requirements, adjust, repair or replace any and all defective or inoperative parts and, on completion, again conduct the complete performance tests.

#### 3.03 INSTALLATION, SUPERVISION AND INSTRUCTION

- 1. The manufacturer shall provide a competent engineer for a total of three eight-hour days, (straight time basis) for the phase of completion for the equipment and two eight-hour days per phase of the project not necessarily consecutive, for the instruction of the Owner's personnel. The instruction period shall start after the test period. Refer to the phasing documents for phasing and time durations.
- 2. Provide three charts of equipment lubrication and maintenance schedules mounted on 1/4" masonite and covered with heat bonded clear plastic laminate.
- 3. Provide a set of start and stop instruction mounted on 1/4" masonite and covered with heat bonded clear plastic laminate at each machine.

3.04 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 18 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required for maintenance during the warranty period.

3.05 MAINTENANCE

1. The contractor shall maintain the refrigeration equipment during the warranty period. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner.
2. The contractor shall maintain the refrigeration equipment until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.
3. The maintenance shall include but not be limited to monthly greasing, equipment checks, phasing test for the addition of new equipment and piping, seasonal drain down, and seasonal filling and restart, and equipment cleaning. Refer to phasing documents.

END OF SECTION

SECTION 23 70 00 - AIR HANDLING AND TREATMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and applicable provisions of the Contract, including General and Supplementary Conditions, Division 1 - General Requirements, and the General Provisions, Section 230000, govern the work of this Division.
2. Refer to specification 230000 2.1 A, B, C, D, E, F, and G for Video recording of material, equipment, operation and training .
3. Requirements given herein may be affected by other related requirements of the project specification. Correlation of the contract requirements is the responsibility of the contractor.

1.02 REFERENCES

1. Perform the work in accordance with the requirements of Section 230000, General Provisions, and with the provisions of all applicable codes and laws.
2. The installation and equipment is to conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.
3. Air Moving and Conditioning Association (AMCA) Standards - Air performance of all air moving devices, shall be rated in accordance with AMCA Standard Test Code 210 and shall be licensed to bear the AMCA certified rating. Sound ratings specified in Section 230000 shall be obtained in accordance with the AMCA Standard 300. They shall be published in accordance with AMCA Standard 301, and the products should bear the AMCA sound certified ratings seal.
4. The quantity and performance criteria for each type of equipment is listed in the equipment schedules.

1.03 SUBMITTALS

1. Procedure
  - a. Prepare and make the submissions listed below and in Section 230000 in accordance with the procedure specified in Section 230000.
2. Shop Drawings
  - a. Air Handling Equipment and all Related Equipment
  - b. Fans
  - c. Fan Performance Curves

- d. Heating and cooling coils
  - e. Filters
  - f. Variable volume, constant volume, fan terminal units
  - g. Fan coil units
  - h. Cabinet and Unit Heaters
  - i. Dust Collection Equipment
  - j. Automobile Exhaust System
  - k. Fume Hood Exhaust System
  - l. Fume Extraction System
  - m. Air Door
3. System Testing
- a. Perform operating tests and instruct Owner's personnel as specified in Section 230000. Produce and maintain ventilation and air conditioning under operating criteria determined in advance by agreement with the Architect.

## PART 2 - EQUIPMENT

### 2.01 GENERAL REQUIREMENTS

- 1. Construct all apparatus of materials suitable for the conditions encountered during operation.
- 2. All factory applied acoustical and thermal insulation, including facing and adhesives, sealants and paint, to be fire-resistant or non-combustible, and shall conform to the requirements of NFPA and local codes.
- 3. Construct all equipment in accordance with requirements of the local and state codes. Construct all pressure vessels that fall within the scope of ASME Code for unfired pressure vessels to conform to the code and bear the code stamp. Furnish three copies of National Board Inspection and Test Report.
- 4. Match and balance all system components to achieve compatibility of equipment for satisfactory operation and performance throughout the entire operating temperature and control range.
- 5. Provide all controls, wiring, piping, valves, tubing, accessories and other components necessary to make a complete operating assembly.
- 6. Test and rate all fans in accordance with the standards of AMCA. All fans must bear the AMCA rating seal.

7. Mount grease fittings directly on bearings unless the bearings are not visible or inaccessible. Then provide easily accessible extensions to bearing lubrication fittings.
8. Balance all fan wheels and other moving components statically and dynamically. Drill all fan shafts on the center line to receive a tachometer point.
9. Submit to the Engineer for approval complete curves of fan performance at the operating speed.
10. Provide coil covers on all coil headers which are installed outside of the air stream.
11. All filters shall be U.L. Class I.
12. Certify unit performance in accordance with ARI standard 410-72.
13. Submit to the Engineer for approval complete sound power data at the operating speed.
14. Motors to be premium high efficiency type with guaranteed minimum efficiency rated in accordance with IEEE standard 112, method B. Refer to Specification Section 230513 for required motor efficiencies and acceptable manufacturers.
15. Fans scheduled for variable speed duty shall be equipped with motors compatible with and specifically designed for variable speed operation. Coordinate with the manufacturer of the variable speed drive as specified in Section 230513.

2.02 ROOFTOP AIR HANDLING UNIT (AC-1, 2, 3, 4, 5, 6, 11, 13 & HV-1)

1. Description
  - a. Air Handler - Factory assembled and tested; designed for roof or slab installation; and consisting of chilled water cooling coils, steam heating coils, fans, energy recovery section, filters, starters, disconnects, dampers and damper operators.
2. Construction:
  - a. Unit shall be completely factory assembled, piped and wired and shipped in one section.
  - b. Unit shall be specifically designed for outdoor roof top application with a fully weatherproof cabinet.
  - c. All cabinet walls, access doors, roof and floor shall be a high performance composite panel constructed with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core providing a rigid, impact resistant surface.

- 1) The walls of the coil and air tunnel compartments shall be 2 inches thick with a minimum R value of 12.5.
  - 2) The roof of the air tunnel compartments shall be sloped at a minimum of ¼ inch per foot and shall be an average of 2 ½ inches thick and an R value of 15.7.
  - 3) The entire base or floor shall be 1 inch thick with a minimum R value of 6.25.
  - 4) The access doors shall be 2 inches thick with a minimum R value of 12.5. The perimeter cross section shall be stepped to allow an overlap of the panel wall and compression of a full perimeter gasket within the cabinet panel wall.
  - 5) The foam shall have a minimum density of 2 pounds per cubic feet.
  - 6) All foam material shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610 degrees F.
  - 7) All panels shall have a thermal break with no metal path from inside to outside.
- d. Paint finish shall be capable of withstanding at least 2000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
  - e. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form.
  - f. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
  - g. Access to filters, heating and cooling sections, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn lockable latches. Door fastening screws are not acceptable. The blower access door shall be bolted closed.
  - h. Access doors shall have stainless steel hinges and full perimeter gasketing.
  - i. All openings through the base pan of the unit shall have upturned flanges of at least 1/2" in height around the opening through the base pan.
  - j. Air side service access doors shall have rain break overhangs.
  - k. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

1. Unit shall be furnished with 304 stainless steel drain pans.
  
3. Supply Fans:
  - a. The fan shall be direct drive single width single inlet un-housed airfoil centrifugal, plenum fans. Supply fans shall have all aluminum construction. Each air handler shall be equipped with a minimum of two independent direct drive supply fans; each fan to have its own motor and VFD. Fans attached to 1760 rpm motors shall be rated for a minimum of 1800 RPM maximum speed. Fans attached to 1170 rpm motors shall be rated for a minimum of 1200 RPM maximum speed. Direct drive fans shall be directly connected to and supported by the motor shaft. Motor bearings shall be rated for 200,000 hours service and shall have external lubrication connections. Fan(s) and motor(s) shall be dynamically balanced, and the entire fan assembly mounted on rubber isolators. Supply air shall be from the bottom of the cabinet. Motors shall be premium efficiency inverter rated only.
  
4. Outside Air:
  - a. Shall be a fully modulating enthalpy-based economizer for control by others with a DDC signal. The outside air damper and return air damper assembly shall be constructed of extruded aluminum, hollow core, air foil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 in. w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure.
  
5. Additional Fan Sections:
  - a. Power Return Fans  
Axial flow direct drive fans shall be constructed of a polymeric material with fiberglass reinforcement and adjustable blade pitch. Direct drive fans shall be directly connected to and supported by the motor shaft. Motor bearings shall be rated for 200,000 hours service and shall have external lubrication connections. Fan(s) and motor(s) shall be dynamically balanced. (For Variable Volume Systems VFD drive(s) shall be factory mounted and wired to the fan motor(s).)
  
6. Energy Recovery:
  - a. The rooftop unit shall have a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
  - b. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

- c. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- d. The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
- e. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
- f. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- g. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the ARI Certified Products
- h. The exhaust fan(s) shall be backward inclined type. Fan(s) and motor(s) shall be dynamically balanced. A back draft damper shall be included with the exhaust fan. Outside air filters shall be 4" thick fiberglass pleated with an ASHRAE efficiency of 30%.
- i. Exhaust fan motors shall be premium efficiency inverter rated only. Motors shall have ball bearings rated for 200,000 hours service and external lubrication connections.
- j. Each unit shall be fitted with two independently operable fans for reliability and redundancy.



7. Filters:
  - a. Filters shall be 4" thick fiberglass pleated filters with an ASHRAE efficiency of 65% and a MERV rating of 11.
  - b. 5/16" lint screen pre filters upstream of the standard filters
  - c. Clogged filter switch
  - d. Direct dial reading Magnehelic gauge mounted in the controls compartment.
  
8. Cooling Coils (not on HV-1):
  - a. Shall be copper tube with aluminum fins mechanically bonded to the tubes.
  - b. Chilled water coil fin design shall be sine wave rippled.
  - c. Drain pan(s) shall be fabricated of 304 stainless steel.
  - d. Coils shall have galvanized steel end casings.
  - e. Coils shall be furnished with a double sloped drain pan for the positive drainage of condensate.
  - f. A drain connection shall be provided on each side of the unit. The manufacturer shall provide a P-trap condensate drain fitting for field installation to the drain connections.
  - g. Provide space for future cooling in the heating and ventilation only units.
  
9. Glycol Hot Water Heating Coils
  - a. Coils shall be certified in accordance with AHRI Standard 410 and be leak tested.
  - b. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - c. Coil shall be located in the reheat position downstream of the supply fans.
  - d. Control valves shall be field supplied and field installed.
  
10. Controls:
  - a. Field Installed DDC Controls – refer to Section 230923.

11. Power Option:
  - a. Unit shall be provided with a factory installed and wired internal disconnect.
  - b. Unit shall be provided with a factory installed and wired 115 volt, 15 amp ground fault service receptacle powered with a 1.5 KVA transformer.
12. Roof Curbs
  - a. Roof curbs shall be constructed of minimum 14 ga. galvanized steel exterior. Curbs are to be fully gasketed between the curb top and unit bottom using 1.5" thick neoprene foam isolation gasket, with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasketing shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
  - b. Curb shall conform to the applicable seismic code, as required by Section 230000.
  - c. Curb shall be equipped with 2" deflection spring and rubber isolation. Refer to Section 230548 for requirements.
  - d. Curb shall be solid bottom with 2" double wall construction with perforated galvanized metal interior and acoustical fill between inner and outer wall on all sides and bottom.
  - e. Curb supplier shall submit acoustical performance analysis showing unit fan performance by octave band and effect of curb and duct appurtenances on room acoustic level.
13. Manufacturer:            Model/Series  
AAON                            RN  
Trane                            Climate Master  
Annexair                        ERP

2.03 Rooftop Air Handling unit (AC-7, 8, 9, 10A, 10B, 12, 15, 16, HV-2, HV-3 & HV-4)

1. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of chilled water coil, steam coils exhaust fan), return fans, filters, electrical starting gear and appurtenances, dampers and damper operators.
2. Construction:
  - a. Unit shall be completely factory assembled, piped and wired and shipped in one section.
  - b. Unit shall be specifically designed for outdoor rooftop application with a fully weatherproof cabinet.

- c. Cabinet shall be constructed entirely of G90 galvanized steel with the exterior constructed of 20 gauge or heavier material.
- d. Paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure. Unit exterior shall be “Gray” in color.
- e. The unit roof shall be sloped or cross-broken to assure drainage.
- f. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form.
- g. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
- h. Access to filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn handles. Door fastening screws are not acceptable.
- i. Access doors shall have full-length stainless steel hinges and full perimeter gasketing.
- j. All openings through the base pan of the unit shall have upturned flanges of at least 1/2” in height around the opening through the base pan.
- k. Air side service access doors shall have rain break overhangs.
- l. All air tunnel doors on 16-30 ton model sizes shall be 1” thick high performance composite panel constructed with G90 galvanized steel on both sides and a closed cell polyurethane foam interior core with a minimum R value for the doors of 6.25.
- m. Control cabinet doors on 16-30 ton model sizes and all access doors on 2-15 ton model sizes shall have an internal metal liner to protect the ½” thick, 1 ½ lb. density fiberglass door insulation.
- n. The interior air side of the cabinet on 2-15 ton models shall be entirely insulated on all exterior panels with 1” thick, 1 1/2 lb. density fiberglass insulation enclosed by double wall galvanized insulation liners.
- o. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.
- p. Unit shall be furnished with 304 stainless steel drain pans.

3. Supply Fan:

- a. Blower shall be entirely self-contained on a slide deck for service and removal from the cabinet.
- b. All belt drive blowers shall have backward inclined blades.
- c. Adjustable V-belt drive shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.
- d. Blowers, drives and motors shall be dynamically balanced.
- e. VFD drive(s) shall be factory mounted and wired to the fan motor(s).
- f. Motors shall be premium efficiency inverter rated only. Motors shall have ball bearings rated for 200,000 hours service and external lubrication connections.

4. Outside Air Management:

- a. Units shall have a 0-100% economizer consisting of a motor operated outdoor air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2" w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure. Barometric relief dampers shall be provided as part of the economizer option.
  - 1) Economizer shall be furnished with a DDC actuator for control by others.
- b. Power Exhaust/Relief Fans (Where No Energy Recovery is Scheduled)
  - 1) Shall use belt drive backward inclined fan(s).
  - 2) The control shall be on-off (with a VFD factory mounted and wired to the fan motor).
  - 3) Exhaust air relief dampers shall be sized for 100% relief.
  - 4) Fan(s) and motor(s) shall be dynamically balanced.
  - 5) Motors shall be premium efficiency inverter rated only. Motors shall have ball bearings rated for 200,000 hours service and external lubrication connections.

5. Energy Recovery:
- a. Where scheduled on the drawings, the rooftop unit shall have a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
  - b. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
  - c. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
  - d. The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
  - e. Wheels greater than 25" in diameter shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
  - f. Wheels 25" and less in diameter shall be provided with a monolithic removable energy transfer matrix. Wheel frame construction shall be a welded hub and rim assembly of stainless, plated and/or coated steel. Monolithic wheel shall be removable and replaceable from the cassette frame when the cassette frame is taken out of the unit. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
  - g. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
  - h. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the

cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the ARI Certified Products

- i. The exhaust fan(s) shall be backward inclined type. Fan(s) and motor(s) shall be dynamically balanced. A back draft damper shall be included with the exhaust fan. Outside air filters shall be 4" thick fiberglass pleated with an ASHRAE efficiency of 30%.
  - j. Exhaust fan motors shall be premium efficiency. Motors for use with a VFD shall be premium efficiency inverter rated only. Motors shall have ball bearings rated for 200,000 hours service and external lubrication connections.
6. Filters:
- a. 4" thick fiberglass throwaway filters with an ASHRAE efficiency of 65% and a MERV rating of 11.
  - b. 5/16" lint screen pre filters upstream of the standard filters.
  - c. Clogged filter switch
  - d. Direct dial reading Magnehelic gauge mounted in the controls compartment.
7. Glycol Hot Water Heating Coils
- a. Coils shall be certified in accordance with AHRI Standard 410 and be leak tested.
  - b. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - c. Coil shall be located in the reheat position downstream of the supply fans.
  - d. Control valves shall be field supplied and field installed.
8. Chilled Water Coils (not on HV-2, -3 or -4):
- a. Unit shall be provided with a 4 (6) row chilled water cooling coil, with copper tubes with aluminum fins mechanically bonded to the tubes.
  - b. Chilled water coil fin design shall be sine wave rippled.
  - c. Chilled water coils shall have galvanized steel end casings.
  - d. Chilled water coils shall be furnished with a double sloped drain pan for the positive drainage of condensate.

- e. Chilled water coil drain pan shall be fabricated of 304 stainless steel.
  - f. Provide space for future cooling in the heating and ventilation only units.
9. Controls: Field Installed DDC Controls – Refer to Section 230923.
10. Power Accessories:
- a. Unit shall be provided with a factory installed and wired 115 volt, 12 amp ground fault service receptacle powered by a 1.5 KVA transformer.
  - b. Unit shall be provided with a factory installed and wired internal disconnect.
11. Roof Curbs
- a. Roof curbs shall be constructed of min 14 ga. galvanized steel exterior. Curbs are to be fully gasketed between the curb top and unit bottom using 1.5” thick neoprene foam isolation gasket, with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasketing shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
  - b. Curb to be double wall solid bottom acoustical design min 2” thick with perforated galvanized interior enclosing acoustical batting over all sides and bottom.
  - c. Curb to be fitted with 2” deflection (min) spring isolation rail. Refer to Section 230548 for requirements.
  - d. Entire assembly shall be certified to meet prevailing local seismic code. Vendor to provide certification documents stamped and signed by an engineer licensed in CT.
12. Manufacturers:            Model/Series:  
AAON                            RN  
Trane                            Climate Master  
Annexair                        ERP

2.04 ROOFTOP AIR HANDLING UNIT – 100% OUTSIDE AIR (AC-14)

1. General:
- a. Units shall be completely cleaned and vacuumed. All pipe and duct openings shall be plugged or covered in such a manner to prevent entrance of foreign matter. Units shall be delivered with factory installed shipping skids or lifting lugs. Items/Components that are shipped loose shall be packed in separate protective packages.

- b. The Air Handling Unit sections shall be shrink-wrapped prior to shipment using 10 mil. plastic sheet. All openings shall be suitably protected during shipping. Prior to the shipment from the factory, the manufacturer shall inspect the insides of each unit and clean inside surfaces that have visual appearance of oil, dirt, dust, rust, chips or grease.
  - c. Store Air Handling Units in safe, clean and dry place and away from construction traffic.
2. Unit Base
- a. The entire unit shall be assembled on 6" high Channel out of structural steel with integral cross support members designed to carry the component load. The base cross members shall be sized to keep the structural integrity of the base frame during rigging and handling. After construction the base shall be cleaned and painted with a rust inhibitor paint. The base frame shall have properly located lifting lugs, which are an integral part of the channel allowing ease of rigging and insuring the unit frame does not deflect more than 1 inch for 15 ft. of span.
3. Cabinet / Housing.
- a. The unit shall be constructed out of 2" thick wall and roof panels. The panel will be insulated with 2" thick – 3.5 lb/cft mineral wool insulation (Insulation to have facing erosion resistant up to 5000 fpm where there is a perf. liner). The panels' outer skin shall be made out of painted 18G Solid Satin Coat Steel Sheet in accordance with ASTM-653, Commercial quality, and inner skin to be 20G- G90. Fan Sections to have 20G G-90 Perf liner – 23%, 3/32" openings @3/16" staggered. The inner skin shall be hemmed on all four sides to eliminate any sharp edges. (Unhemmed inner skins are not acceptable) The panels are to be internally joined together with self tapping screws with 100% solid cross linked butyl preformed rubber sealant type Tremco 440 tape between each panel and then caulked to prevent water and air leakage. The housing panel deflections are limited to 1/200th of the span dimension while under positive and negative pressure.
  - b. The exterior panels shall be fastened to the base through Rain Lip Type Z strip hemmed at the exterior end. (Unhemmed Z-strips are not acceptable) installed around the perimeter. The Z strips will be stitch welded to the base floor with Tremco 440 tape between Z strip and base of panel. This will be continuously caulked with Vulkem 116 gun grade polyurethane sealant conforming to US Federal & ASTM specifications in water and humid areas like drain pan & humidifiers, and with Thermoplastic Elastomeric sealant Tremco 830 sealant in general areas. Z strip to be mitred at time of assembly before being clamped into position for assembly. Sections or modules shall be designed to be fastened together in the field with closed cell neoprene gasketing.
  - c. Coil Removable Panels: All coils shall have bolted removable panels to facilitate easy access and removal of coils. The panel shall be made similar to wall panels.



- d. Unit Floor: The unit floor shall be constructed of 16Ga G-90 galvanized steel sheet. The unit floor shall be screwed to the base channel. The supply air and return air openings shall have 2 inch duct connecting flanges. Underneath the unit, floor shall have 20 Gauge liner Steel Sheet in accordance with ASTM-653, Commercial quality, Hot dip Galvanized steel with G90 Zinc- Coating to Triple Spot test Method with 3" thick-3/4 lb/cft density unfaced fiberglass insulation behind.
  - e. Extruded Aluminum Frame Access Doors with one piece side mounted santoprene gaskets:
    - 1) Hinged access doors shall be wide enough to allow easy access for service maintenance and minimum of 18" wide. The door, frame & outer skin shall be of minimum 18 Gauge galvanized steel whereas inner skin shall be 20G G90. The door will be fitted with stainless steel Piano hinges and a minimum of two (2) Ventlock VL-260 Handles, the door gasket shall be of bulb type. Access doors shall be placed at locations as shown in the drawing and shall have 1/4" tempered wired reinforced windows 8" X 12" if indicated on the drawings. The doors will open inward or outward according to positive or negative pressure in the respective sections. Doors shall be fully gasketed with one piece santoprene gaskets installed on side of the frame. Gaskets installed at the edge is not acceptable. All doors shall be ETL Tested and have compliance to UL1995 safety standard for heating and cooling.
    - 2) Removable panels shall be provided for heating and cooling coils. Access doors and panels shall be of the same thickness and construction as the wall panels.
4. Coil Racks, Drain & Drip Pans.
- a. Drain pan shall be made out of 16 G Stainless Steel S/S 304 2B Finish material, continuously welded and positively sloped for drain on side as shown on the drawing with 1 1/2" NPT drain connection with a minimum depth of 3" at drain. Drain piping shall be 304 stainless steel with each drip pan individually piped to the drain pan.
  - b. For ease of removal the coil shall be supported on individual racks. The racks shall be made of formed 16Ga Galvanized steel channel. One side of the coil shall have a removable panel for coil pull out and removal and shall be designed to permit the removal of individual coil sections without disturbing remaining coils.
5. Inner skin at Drain Pan
- a. The inner skin at coil, drain pan section, humidifier section shall be 20G solid Hot Dip Galvanized Steel Sheet in accordance with ASTM-653, Commercial quality, G90 coating equivalent to Z275 measured in accordance with Triple Spot Test Method.

6. Paints: The exterior of the indoor unit shall be cleaned and painted with Amerlock 400 capable of 5% salt spray test of 3000 HOURS AS PER (ASTM B117), with a top coat of Amershield Polyurethane.
7. Magnehelic Filter Gauge: A differential Pressure Gauge for measuring the pressure drop across each filter bank shall be provided. The gauge shall be diaphragm-actuated dial type series 2000, 3 7/8" dia. white dial with black figures & graduations, 0 to 1" water gauge operating ranges and will have two static pressure tips and vent valves. Static Pressure tips shall be factory piped.
8. Filters
  - a. Filters shall be sized according to 500 FPM face velocity and include 2" prefilters
  - b. Pre Filter media shall have an average efficiency of 25-30% on ASHRAE Test Standard 52-76
  - c. Holding frames shall be face loading type, 16Ga galvanized steel and shall be equipped with gaskets and four spring type positive fasteners.
  - d. Filters shall be equal to Farr 30/30 and type 8 holding frames and springs.
9. Dampers & Louvers
  - a. Provide unit with factory mounted outside, relief and return air dampers (where required) of galvanized steel blades, with silicone blade seals in galvanized frame, in opposed blade arrangement with non-slip keyed connecting rods and linkages. Permanently secure damper blades on a single shaft with self-lubricating nylon bearings. Position damper blades across short air opening dimension. Maximum leakage shall not exceed 2 percent at 4 inch water gauge differential pressure when sized for 2000 fpm face velocity
  - b. Provide unit with factory mounted stationary drainable blade louvers where shown. Louvers frame shall be constructed from heavy gauge 6063-T5 aluminum 4" deep with a 0.081" nominal wall thickness. Blades: Drainable design, heavy gauge extruded 6063-T5 aluminum, 0.081 in. nominal wall thickness, positioned at 37° and 45° angles on approximately 4 in. centers. Birdscreen to be 3/4 in. x 0.051 in. flattened expanded aluminum in removable frame, inside mount (rear).
10. Centrifugal Fans
  - a. The fan shall be a Double-Width Double Inlet type designed with scroll housing and having aerodynamically designed spun inlet cones incorporating a non-overloading type backward inclined airfoil Aluminum blades continuously welded around all edges to a wheel shroud and heavy gauge reinforced steel back plate. The assembly shall have structural steel frame. The fan shall have inlet plate incorporating removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel.

- b. All wheels shall be statically and dynamically balanced on precision electronic balancer to a level of G6.3 (Per ANSI 2-19 or better). All shafts shall be solid steel accurately turned, ground, polished and ring gauged for accuracy. Shaft shall have first critical speed at least 1.35 times the maximum speed of the fan.
- c. All fans shall have heavy duty, grease lubricated, anti friction ball or roller bearing, self aligning, pillow block type bearing selected for minimum average life ABMA L50 of 200,000 hrs and fitted with regreasable fittings with option of extending the lube lines for easy re-lubrication.
- d. Each fan component shall be thoroughly degreased before application of rust-preventive blue primer. After complete assembly, a finished coat shall be applied to the assembly.
- e. Fan performance shall be based on test conducted in accordance with AMCA standard test code for air moving devices and shall be licensed to bear AMCA seal. Drives shall be V-belt and sized for 1.5 times the fan motor horsepower. The fan shall have an OSHA belt guard.

11. Chilled Water Cooling Coil.

- a. Primary surface shall be round seamless 5/8 inch O.D. by .020 inch thick copper tube on 1.5 inch centers, staggered in the direction of airflow. All joints shall be brazed. Secondary surface shall consist of .0075 inch rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Bare copper tube shall not be visible between fins and the fins shall have no openings punched in them to prevent the accumulation of lint and dirt. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
- b. Casings shall be constructed of continuous galvanized steel. Coil side plates shall be of reinforced flange type. Coils shall have equal pressure drop through all circuits. Coils shall be circuited for counter flow heat transfer to provide the maximum heat transfer rates. Headers on coils shall be seamless copper tubing. The headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility. Supply and return connections on water coils shall be copper with male pipe threads. The complete coil core shall be tested with 315 psig air pressure under warm water and be suitable for operation at 250 psig working pressures. Individual tube tests and core tests before installation of headers shall not be considered satisfactory. Water cooling coils shall be circuited for drain ability. Use of internal restrictive devices to obtain turbulent flow shall not be acceptable. Vents and drains shall be furnished on all water coils. Coils shall be rated in accordance with ARI.

- c. Coils shall be mounted in galvanized holding racks. Water coil supply and return connections shall be extended to the unit exterior. Water coil drain and vent connections shall be accessible from the interior of the Unit and shall not be extended through the unit casing. Cooling coils shall be mounted in an insulated pitched 304 stainless steel condensate pan.
12. Air-to-air heat exchanger
- a. Air-to-air heat exchanger shall be a stationary aluminum flat plate type. Heat transfer surface shall be formed aluminum plates 0.008" thick with enhanced surface corrugation for increased performance. Exchanger frame profiles shall be all aluminum with coated sheet metal end plates. Exchanger shall be capable of withstanding a pressure difference between airflows of up to 7.2" w.g. without deforming air passages. Unit shall be capable of operating in temperatures up to 190°F standard construction. Standard cell construction shall have a maximum cross contamination between airflows of 0.01% of total airflow. The entire cell shall be capable of being visibly inspected and cleaned as required.
13. Glycol Hot Water Heating Coils
- a. Coils shall be certified in accordance with AHRI Standard 410 and be leak tested.
  - b. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - c. Coil shall be located in the reheat position downstream of the supply fans.
  - d. Control valves shall be field supplied and field installed.
14. Roof Curb: 12" high, insulated, made with minimum 14G galvanized steel sheet. Includes Z-strip for weatherproofing.
15. Vibration: The overall vibration level on any of the bearing housings on the fan and motor taken in horizontal, vertical or axial direction shall not exceed 0.10 in/sec peak to peak . Any discreet frequency shall not have an amplitude exceed 0.03 in/sec peak to peak. Any discreet frequency above 15 times the rotating speed shall not exceed 0.098 in /sec. All vibration spectra to be taken with a maximum frequency of 120,000 cycle
16. Casing leakage: Tests shall verify that casing leakage for air unit is less than 1% of design airflow when tested at 1.5 times fan shut off pressure. Determine leakage using the testing methods as described in SMACNA HVAC Air Duct Leakage Test Manual. Provide temporary sealing of openings as required for leakage testing.

17. Electrical Specification and Tests

- a. Wiring and Disconnect: The electrical panel shall be NEMA 3R rated and mounted on the unit exterior as shown on the General Arrangement Drawing. The electric panel shall consist of a non-fused disconnect, Electrical panels shall bear an ETL label. All wiring 120 volt and higher and wire size #8 and smaller shall be run in MC Cable. All wire size #6 and larger shall be run in EMT. Fan motors requiring wire run in EMT shall have a 2' length of seal tight at the motor junction box. Low voltage wiring shall use plenum cable, installed external to the conduit. Starter coils shall be 24 volt AC for contactors rated 75 amps or less and 120 volt AC for contactors rated greater than 75 amps.
- b. Lights & GFI Receptacle - Vapor tight lights shall be provided in access compartments as shown on the General Arrangement drawing. Lights shall be wired to a single switch on the unit exterior. A GFI receptacle shall be mounted next to the light switch. A separate 120 volt power connection shall be required at the GFI receptacle to provide power for the lights and receptacle.
- c. Controls: AHU manufacturer will factory mount all the controls including sensors & actuators to be supplied by temperature control contractors. These controls shall be wired and terminated to a termination strip at the outer casing of the AHU.
- d. Test: Energize and run test for not less than ½ hr all electrical components to prove satisfactory operation, and that all circuits are free from short circuits and unspecified ground. Each Variable speed drive unit shall be completely functionally tested under actual motor load. Test that the insulation resistance to ground of all non-grounded circuits is not less than one mega ohms at 1000 volts DC. Arrange to have units factory inspected and perform other testing as required to obtain ETL Label.

18. Testing & Commissioning

- a. Unit manufacturer shall provide the services of a trained technician to supervise the installation of the unit and to perform the start up of the unit. After the unit is installed, perform inspection, start-up and checkout of the equipment. Do not start up equipment until the following operations are complete:

19. Roof Curbs

- a. Roof curbs shall be constructed of min 14 ga. galvanized steel exterior. Curbs are to be fully gasketed between the curb top and unit bottom using 1.5" thick neoprene foam isolation gasket, with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasketing shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
- b. Curb to be double wall solid bottom acoustical design min 2" thick with perforated galvanized interior enclosing acoustical batting over all sides and bottom.

- c. Curb to be fitted with 2" deflection (min) spring isolation rail. Refer to Section 230548 for requirements.

Entire assembly shall be certified to meet prevailing local seismic code. Vendor to provide certification documents stamped and signed by an engineer licensed in CT.

20.	Manufacturer:	Model:
	MAFNA Air Technologies Inc. 519-624-4622	Custom
	AAON	Custom Rooftop
	Cambridgeport	Custom Rooftop

#### 2.05 GAS FIRED MAKEUP AIR HEATER

1. Unit shall be factory fabricated, direct fired makeup air unit, with: fan; motor and drive; filter; outside air damper; natural gas heating section; filter; access doors; remote control panel with indicator lights; fuel burning safety equipment; temperature control system; gas piping and control valve with ductstat; vented extension; interlock control panel with starter, fusing, interlock relay and transformer; and all accessories and hardware.
2. Unit shall be UL listed, and conform to requirements of ANSI Z83.4, NFPA 54 and the National Fuel Gas Code.
3. Cabinet - galvanized steel formed panels with external channel reinforcing. Finish external surfaces with primer base coat and finish coat of enamel.
4. Fan - centrifugal, forward curved type, double inlet. Wheel - keyed to steel shaft. Permanently lubricated bearings. All components exposed to the air stream shall be constructed of galvanized steel or coated with an enamel coating. Blower section to be fully insulated with UL listed Class 1 foil faced fiberglass insulation, 1" thick.
5. Bearings - self-aligning split pillow block with grease lines extended to the outside of the casing. Bearings shall be rated for a minimum of 200,000 hours.
6. Adjustable V-belt drives.
  - a. A complete matched set to transmit the power to the driven equipment; not less than two belts per drive. Provide one spare set of belts for each size drive supplied.
  - b. Sheaves: Adjustable plus or minus 10%. When motor is 15 HP or over, use companion type sheaves.
  - c. Belts: Reinforced rubber or neoprene.
  - d. Service rating: Not less than 200% of the maximum estimated load; greater if specified for particular apparatus.
  - e. Minimum efficiency: 95%.

7. Motors - Premium efficiency type with guaranteed minimum efficiency as stated in Section 230513. General Electric Co. "Energy Saver" or the approved equal of Westinghouse or Marathon.
  
8. Burner
  - a. Burner shall be a direct fired, draw through type, consisting of non-clogging, stainless steel combustion baffles attached to a cast iron gas supply section with no moving parts. The burner shall be capable of 100% thermal efficiency, with a maximum turndown ratio of 30 to 1.
  - b. An ultraviolet flame detection system shall be used to prove flame.
  - c. A spark igniter shall be provided to initiate combustion.
  - d. Gas train shall consist of pressure regulator, solenoid gas valve, modulating gas valve, manual shut off, manifold pressure tap. Gas pressure regulator shall be factory set to regulate gas flow to main burner.
  - e. Ignition system shall be a stepped direct ignition system, with spark ignited proved pilot before full burner operation. System shall comply with ANSI Z83.4.
  - f. Electrical controls shall include motor contactor/overload, grounding lugs, terminal blocks, Heat/No Heat switch, flame safety device, airflow switch, transformer, modulating amplifier, ignition module, high temperature limit control, and temperature selector.
  
9. Accessories.
  - a. Intake section with 1" thick, UL listed, cleanable Class 2 filter.
  - b. A discharge sensor to measure discharge air temperature, and send signal to controller, for modulation of gas valve to maintain discharge temperature.
  
10. Manufacturer: Model/Series:  
Greenheck DGX  
Carroll Manufacturing Co. ARES  
Trane DFOA

**2.06 FANS: ROOF MOUNTED UTILITY SET**

1. Roof exhaust fans shall be of the centrifugal belt-driven or direct-drive type as indicated on Drawings. Fans shall be of capacities and characteristics as scheduled on Drawings and specified herein.
  
2. Construction of the fan housing shall be of heavy-gauge aluminum.

3. All spun parts shall have a rolled bead for added rigidity and shall be specially spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.
4. The fan wheel shall be all-aluminum of the centrifugal blower type featuring backward-inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced. Inlet cone shall be aluminum and of the centrifugal blower type. Motor and drives shall be enclosed in a weathertight compartment, separate from the exhaust air stream. Air for cooling the motor shall be supplied to the motor compartment by way of an air passage from an area free of contaminated exhaust fumes. Motors shall be of the duty, permanently lubricated, sealed ball-bearing type. Drives shall be sized for 165 percent of motor horsepower capabilities and of the cast-iron type, keyed to the fan and motor shafts. Variable pitch drives shall be standard. Fan shaft shall be of steel construction, turned, ground, and polished to precise tolerances in relationship to the hub and bearings. Drive belts shall be of the oil-resistant, non-static, non-sparking type with life expectancy of over 24,000 hours.
5. Bearings shall be flanged and of the permanently lubricated, permanently sealed, ball-bearing type capable of over 200,000 hours bearing life. The entire drive assembly and wheel shall be removable, as a complete unit, from the support structure without disassembling the external fan housing. The complete drive assembly shall be mounted on rubber vibration isolation.
6. Fans shall be licensed to bear the AMCA ratings seal for air and sound performance.
7. Fans shall be furnished with pre-fabricated 12” roof curbs. Roof curbs shall have 2-inch raised cant strip and wood nailer. Curb shall be aluminum construction. Fans shall be furnished with automatic backdraft damper and weather hoods to protect motor and drive components.
8. Fans shall have chemical-resistant heresite finish and spark-proof construction.
9. 

Manufacturers:	Model/Series:
New York Blower	GP
Greenheck	SWB
Loren Cook	CP Series



2.07 FUME HOOD EXHAUST FAN - HIGH PLUME LABORATORY EXHAUST

1. General
  - a. Base fan performance at standard conditions (density 0.075 Lb/ft<sup>3</sup> ).
  - b. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
  - c. Each fan shall be belt driven.
  - d. Fans to be equipped with lifting lugs.
  - e. Fan to be coated steel with a minimum of 4 mils of HiPro Polyester Resin
  - f. Fasteners to be 316 stainless steel.
  
2. Fan Housing And Outlet
  - a. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
  - b. Fan housing shall be welded steel with a minimum of 4 mils of HiPro Polyester Resin. No uncoated metal fan parts will be allowed.
  - c. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
  - d. Provide housing drain for removal of rain and condensation.
  - e. An access door shall be supplied in the housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
  - f. Standard finish color to be ivory.
  
3. Fan Impeller
  - a. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically Grade G6.3 per AMCA Standard.
  - b. Fan impeller shall be manufactured of aluminum, fully welded and coated with a minimum of 4-6 mils of HiPro Polyester resin.
  
4. Fan Bypass Air Plenum
  - a. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of bypass damper.
  - b. For variable volume systems, a bypass air plenum shall be provided as shown on drawings. The plenum shall be equipped with a bypass air damper and intake air hood with birdscreen for introducing outside air at roof level upstream of the fan. The plenum shall be constructed of fully welded galvanized steel, and coated with 4-6 mils of HiPro Polyester resin, and mounted on roof curb as shown on the project drawings. Flexible connectors shall not be permitted.
  - c. Bypass air damper shall be opposed-blade design, and shall be fabricated of aluminum.

- d. A fan isolation damper fabricated of aluminum and coated with HiPro Polyester resin shall be provided as shown on the project documents.

5. Fan Motors And Drive

- a. Motors to be premium efficiency, standard NEMA frame, 1800 RPM, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
- b. Fans submitted that use 900 RPM, 1200 RPM, or are C-Face motors, shall include one spare motor per fan system, in accordance with ANSI Z9.5, section 4.14.7.4, CRITICAL SERVICE SPARES.
- c. Drive belts and sheaves shall be sized for 150% of the motor horsepower, and shall be readily and easily accessible for service, if required.
- d. Fan shaft shall be 316 stainless steel.
- e. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed. Bearings shall have extended lube lines with Zerk fittings.

6.	Manufacturer:	Model/Series
	Greenheck	TCB-LE
	Strobic Air	Tri-Stack
	Twin City	TFE

2.08 FAN: CENTRIFUGAL INLINE - SQUARE CONSTRUCTION

- 1. Factory assembled with all components mounted on a reinforced steel stand.
- 2. Casing: heavy gauge steel, square design, rigidly reinforced and supported, seams permanently sealed airtight. Flanged outlet connection. Provide access doors on two sides for easy access. All components shall be enamel primed and finish painted with enamel.
- 3. Wheel: all aluminum centrifugal backwardly included blades welded or riveted to the side and hub plates. Matching inlet cone.
- 4. Shaft: hot rolled steel, ground, keyed to the wheel.
- 5. Bearings
  - a. Self-aligning, grease lubricated, split pillow block type.

6. Drive: adjustable v-belt, factory set. Drives shall be rated for 165% of rated horsepower.
7. Open drip-proof motor and drive enclosure.
8. Accessories:
  - a. Insulated housing
  - b. Integral disconnect switch
  - c. Companion flanges
  - d. Motorized Backdraft Damper
  - e. Motor cover
  - f. Variable speed controller
  - g. Inlet guards
  - h. Outlet guard
  - i. Inlet vane damper
9. Manufacturer:            Model/Series:  
Loren-Cook                SQIB  
Greenheck                BSQ  
PennBarry                SX

2.09 FAN: CENTRIFUGAL - ROOF MOUNTED - ROUND DOME - ALUMINUM

1. Motor driven centrifugal fan unit built into removable all aluminum weather tight housing; belt drive, designed for roof curb mounting.
2. Fan motor - drip-proof, with disconnect switch. Mount motor driven on vibration isolators.
3. Screen air discharge with removable aluminum (.047") bird screen.
4. Mount fans on prefabricated, double wall aluminum acoustically lined base, with integral sound baffles, minimum 12 inches above the roof.
5. Provide anti-condensate coating or baked epoxy coating on housing.
6. Accessories
  - a. Unit mounted disconnect switch
  - b. Anti condensate coating
  - c. Motorized back draft damper
  - d. UL listing
  - e. Solid state speed controller

7.	Manufacturer:	Model/Series
	Acme Engineering Co.	PR, PN
	Greenheck Fan Corp.	G, GB
	Loren Cook	ACEB, ACED
	Penn Ventilator Co.	DOMEX

2.10 FAN: CENTRIFUGAL - ROOF MOUNTED - UPBLAST - KITCHEN

1. Roof exhaust fans shall be a vertical discharge type. Construction of fan housing shall be heavy gauge spun aluminum. The fan wheel and inlet cone shall be high performance, centrifugal blower.
2. The motor and drive housing shall be completely sealed from the exhausted air and fumes. A felt shaft seal shall be provided. Air for cooling the motor shall be taken into the motor chamber by means of air tubes from a location free of discharge contaminates.
3. The entire drive assembly and wheel, as a unit, shall be removable through the support structure without dismantling the fan housing in any way.
4. The wheel shall be directly connected to the motor shaft.
5. The entire drive assembly shall be mounted on rubber vibration isolators.
6. Fans shall be AMCA approved for sound and air performance.
7. Fans shall be U.L. and N.F.P.A. rated for kitchen exhaust.
8. Mount ventilator on prefabricated, double wall aluminum base, and minimum 12 inches above the roof.
9. Accessories:
  - Pre-fab roof curb (less acoustical baffles).
  - Extended base (fan bottom min. 18" above roof, fan discharge min. 40" above roof).
  - Bird screen.
  - Grease trough.
  - Manual starter.
  - Grease collection container
10. Manufacturer:

Acme Engineering Co.	PUB
Greenheck Fan Corp.	CUBE
Loren Cook	VCR
Penn Ventilator Co.	FUMEX

2.11 FAN: CENTRIFUGAL - CEILING CABINET

1. Centrifugal, with fan wheel direct connected to a 1075 RPM motor, mounted in an acoustically lined cabinet. Top horizontal discharge.
2. U.L. and AMCA rated.
3. Manufacturer: Model/Series:  
Acme Engineering Co. MASTER-ETTE  
Greenheck Fan Corp. SP, CSP  
Loren Cook GEMINI  
Penn Ventilator Co. ZEPHYR

2.12 AIR INTAKE / RELIEF HOOD: ROUND DOME - ALUMINUM

1. Gravity intake with all aluminum weathertight housing; designed for roof curb mounting.
2. Screen air inlet with removable aluminum (.047") bird screen.
3. Mount ventilator on prefabricated, double wall aluminum acoustically lined base, minimum 12 inches above the roof.
4. Anodize all visible aluminum components natural aluminum.
5. Manufacturer: Model/Series:  
Greenheck Fan Corp. GRS  
Loren Cook TR  
Twin City

2.13 AIR INTAKE / RELIEF HOOD: LOW PROFILE - ALUMINUM

1. Gravity intake with all aluminum weathertight housing; designed for roof curb mounting.
2. Screen air inlet with removable aluminum (.047") bird screen.
3. Mount ventilator on prefabricated, double wall aluminum acoustically lined base, minimum 12 inches above the roof.
4. Anodize all visible aluminum components natural aluminum.

- |    |                             |         |
|----|-----------------------------|---------|
| 5. | Manufacturer: Model/Series: |         |
|    | Acme Engineering Co.        | EV/EI   |
|    | Greenheck Fan Corp.         | FHR/FHI |
|    | Loren Cook                  | VR/VI   |
|    | Penn Ventilator Co.         | AIRETTE |

2.14 VAV UNIT: LOW PRESSURE

1. Cabinet shall be constructed of zinc coated steel with 1" internal insulation. Insulation shall meet standards of specification section 230700.
2. Air volume damper shall be constructed of extruded aluminum components with nylon fitted bearings. Air leakage shall not exceed 2% at 1" W.G. inlet pressure.
3. Damper operator shall be factory mounted and compatible with space thermostats specified in specification section 230923. Units shall be of the pressure independent type capable of operating with inlet pressures between 1.0 and 3.0 inches of water.
4. Unit shall be factory tested prior to shipment.
5. 

Manufacturer:	Model/Series:
Titus	DESV
Trane	VariTrane
Anemostat	EZT

2.15 VAV UNIT: LOW PRESSURE - HOT WATER REHEAT

1. Cabinet shall be constructed of zinc coated steel with 1" internal insulation. Insulation shall meet standards of specification section 230700.
2. Air volume damper shall be constructed of extruded aluminum components with nylon fitted bearings. Air leakage shall not exceed 2% at 1" W.G. inlet pressure.
3. Damper operator shall be factory mounted and compatible with space thermostats specified in specification section 230923. Units shall be of the pressure independent type capable of operating with inlet pressures between 1.0 and 3.0 inches of water.
4. Unit shall be factory tested prior to shipment.
5. Heating Coil
6. Seamless copper tubes with brazed copper return bends and without internal turbulence inducers. Aluminum plate or helical fins. Red brass headers each with drains and vents.

7. Flanged minimum 16 gauge galvanized steel casings with mounting holes.
8. Mount and arrange components to permit expansion without strain on tubes, headers or casing and with all guides and supports necessary to assure proper alignment and drainage.
9. Support - All units shall be independently suspended from the building structure. Provide auxiliary steel for hanging where required. Resting the units on ceiling structure will not be permitted.
10. 

Manufacturer:	Model/Series:
Titus	DESV
Anemostat	EZT
Carrier	35E
Trane.	VariTrane

2.16 FAN COIL UNIT: CABINET - 4 PIPES

1. Vertical cabinet centrifugal type.
2. Cabinet: 18 gauge, nominal with 16 gauge front panels; channel formed edges around entire perimeter.
3. Chassis: Minimum 18 gauge galvanized steel, reinforced with flanged edges lined with 1/2" thick, 1 lb. density neoprene faced fiberglass. Galvanized steel drain pan with insulating liner.
4. Fan: Double inlet, double width, forward curved, galvanized steel wheel and scroll. Fan, motor and drain pan assembly shall be removable as a unit.
5. Coils:
  - a. Cooling/heating coil: 5/8" O.D. seamless copper tubes, with aluminum fins, mechanically bonded.
  - b. Test coils at the factory for maximum working pressures of up to 300 PSI.
6. Motors: Multispeed permanent split capacitor type directly connected to an extension of fan shaft. Maximum fan motor speed 1100 RPM. Provide integral thermal overload protection. Unit mounted fan speed switch. Provide special motors for all units scheduled with external static pressures of 0.10 inches or greater. Motors shall be capable of delivering scheduled CFM at static pressures indicated.
7. Filter: 1" disposable woven glass.

8. Accessories:
- a. Two-pipe valve package with automatic summer/winter changeover (Trane H-37).
  - b. Four pipe valve package, including two way control valves for hot and chilled water, two stop valves for each service and an air vent on each service. Provide three way chilled water control valves where indicated on plans or in equipment schedules. Control valves shall be provided in conformance with Specification Section 230923
  - c. Tamper proof panel
  - d. Unit sub-base.
  - e. Extended motor oiler lines.
9. Manufacturer: Model/Series:
- |               |          |
|---------------|----------|
| Trane         | Unitrane |
| Carrier       | 42V      |
| International | FXY      |

2.17 DUCTED TYPE FAN COIL FOR CONCEALED OR EXPOSED MOUNTING

- 1. Factory assembled unit including fans, cooling/heating coil, filter, fan, multi-speed motor, drain pan, wiring and controls. Units shall be UL listed.
- 2. Cabinet - galvanized steel with 1/2" of faced fiberglass insulation. Provide collars for supply and return duct connections. Horizontal units shall have a removable bottom access grille.
- 3. Fan - centrifugal, forward curved, double width. Wheel - keyed to steel shaft. All components exposed to the air stream shall be constructed of galvanized steel.
- 4. Motors - High efficiency type, three speed permanent split capacitor type with sleeve bearings and an oil reservoir.
- 5. Chilled/Hot Water coil - 1/2" O.D. copper tubes with aluminum fins arranged to handle 100% of the air quantity without bypass. No internal turbulence inducers. Coils shall be factory tested at 250 PSI. Coil headers of C.I. or copper. Coil casing of galvanized steel. Provide a manual air vent for each coil section. Provide an overflow drain pan connection.
- 6. Accessories.
  - a. Magnehelic 2002AF filter gauge by Dwyer, Inc.
  - b. Extended grease fittings.
  - c. Remote three speed, four position switch for remote mounting
  - d. Drain pan extension
  - e. Control valve package.
  - f. Isolation and balancing valve assembly.
  - g. 24 volt thermostat for wall mounting.



- |    |  |  |
|----|--|--|
| 7. | Manufacturer:<br>Carrier Corp.<br>Trane<br>International | Model/Series:<br>42D series<br>Unitrane<br>CXB/CPY |
|----|--|--|

2.18 UNIT HEATER: HOT WATER/STEAM

1. Horizontal mounted with propeller fan direct connected to electric motor.
2. Coil: Copper tubes with aluminum fins mechanically bonded to the tubes.
3. Casing: Minimum 18 gauge steel with steel fan guard and horizontal deflection or outlet cone louvers. Finish in baked enamel.
4. Motor: Permanent split capacitor with built-in thermal overload protection.
5. 

Manufacturer:	Model/Series:
Modine	HS
Sterling	HS
Trane	UHS

2.19 CABINET UNIT HEATER: HOT WATER

1. Vertical or horizontal centrifugal cabinet type.
2. Cabinet: 16 gauge removable front with 18 gauge side and back panels. Bonderize metal surfaces, and apply one coat of baked on primer. Finish with baked on enamel. Finish color to match samples to be provided by the Architect.
3. Fan: Forward curved centrifugal type, constructed of fiberglass reinforced thermoplastic.
4. Coil: 5/8" O.D. copper tubes with mechanically bonded aluminum fins.
5. Motor: Multispeed permanent split capacity type, connected to an extension of the fan shaft.
6. Filter: 1" disposable woven glass.
7. 

Manufacturer:	Model/Series
Trane	Force-Flo
McQuay	CHF
Sterling	W/RW

2.20 AIR DOORS

1. General: factory-assembled units of sufficient structural strength to be supported from ends without intermediate support. Ship units completely assembled.
2. Cabinet:
  - a. Material: Minimum 16-gage aluminized steel with gray colored powder coat finish with mill aluminum inlet screen, all welded construction. Tamper-resistant construction; parts cannot be disassembled without special tool provided by manufacturer.
  - b. Mounting: Provide for top of wall mounting.
  - c. Removable top and bottom panel for access.
3. Motors: 1/2-HP, three (3) phase, 1 speed, double extended shafts with sealed bearings.
4. Fans: Balanced forward curved centrifugal type, double inlet, double width design, mounted in matched fan housings with aerodynamically formed air inlet venturis. Manufacture wheels and housings from galvanized steel.
5. Discharge Nozzles:
  - a. Provide uniform velocity across width of air door.
  - b. Aperture: 3-1/2 inches slot by width of air door.
6. Vanes: 1-1/2 inches minimum height; constructed of airfoil-shaped aluminum extrusions; adjustable plus or minus 20 degrees to deflect airflow.
7. Location: Front
8. Screen: Perforated pattern [mill aluminum] [stainless steel] with border.
9. Air Inlet Filter: Flat-faced recleanable aluminum with screen.
10. Heating Elements
  - a. Glycol Hot Water Coil: Certified in accordance with ARI 410; constructed from 5/8-inch (15.8 mm) outside diameter copper tube with aluminum fins.
  - b. Characteristics: Design to operate at maximum 250-psig (1720-kPa) and 300 degrees F (149 degrees C) hot water.
  - c. Leak-test under water at 350-psig (2410-kPa) dry nitrogen.
  - d. Factory mount coil on air intake and protect with perforated metal screen.

11. Controls

a. Control Panel:

- 1) UL listed, industrial type, pre-wired, with components consisting of motor starter, terminal strip, motor overloads, and control transformer with 120 volt fused secondary.
- 2) Single power supply.
- 3) Enclosure: Oil-tight and dust-tight NEMA Type 4 enclosure with neoprene door gasket.
- 4) Mounting: Unit mounted.
- 5) Time Delay Relay: Adjustable in field from 0.1 second to 10 hour delay.
- 6) Disconnect Switch: Provide units with non-fused toggle disconnects based on number of power supplies required.
- 7) HAND-OFF-AUTOMATIC Switch: Switch allows manual on-off operation or operation controlled by automatic door switch that activates unit when door opens and deactivates unit when door closes.
- 8) START-STOP Switch: Provide START-STOP push button operation.
- 9) ON-OFF Switch: Allows manual on-off operation.

12. Manufacturer:

Berner  
Mars Air Systems  
Marley

2.21 ADJUSTABLE V-BELT DRIVES

1. For all belt-driven equipment: A complete matched set to transmit the power to the driven equipment; not less than two belts per drive.
2. Sheaves: Adjustable plus or minus 10%. When motor is 15 HP or over, use, companion type sheaves.
3. Belts: Reinforced rubber or neoprene.
4. Service Rating: Not less than 200% of the maximum estimated load; greater if specified for particular apparatus.
5. Minimum efficiency: 95%.
6. Manufacturer:  
Browning Mfg. Co.  
T.B. Wood's Sons Co.  
Maska

2.22 MACHINERY GUARDS

1. Guard all visible moving parts of machinery, including fan belt drives, by barriers constructed of properly supported and easily removed 1-1/4" x 1-1/4" x 1/8" galvanized angle iron frames and 3/4" No. 16 galvanized expanded metal mesh. Round and finish all guard edges.
2. Provide openings equal to twice the diameter of the shaft for the insertion of a tachometer in all machinery guards covering the ends of motor or equipment to allow adjustment of belt tension.

2.23 FILTER GAUGES

1. At each filter bank, provide a mounted 4-1/2" diameter dial gauge with brass valved connection tubing to brass static pressure sensing tips upstream and downstream of the filter bank.
2. Scale: Clean filter drop at mid scale  
Graduated in 0.2" W.G. increments.
3. Manufacturer:            Model/Series:  
F.W. Dwyer Mfg. Co.    Magnehelic Series 2000 or approved equal

2.24 AUTOMOBILE EXHAUST SPRING RETRACTABLE HOSE REEL

1. The vehicle exhaust extraction system shall consist of an Automatic Spring Hose Reel, designed for manual extension and spring return of high temperature flexible exhaust hose. System shall also include a 6" diameter, 25'-0" length of high temperature exhaust hose and tailpipe nozzle.
2. The hose reel side plate mounting support frame shall be constructed of 11 gauge cold rolled steel.
3. Exhaust hose shall be double ply with an inner liner ply of woven fiberglass coated silicone rubber. A helically wound spring steel wire shall be imbedded between the inner liner ply and an exterior ply of woven Nomex coated with silicone rubber. The assembly shall be double wound with a treated Nomex cord and heat vulcanized to provide a greater strength and serviceability. The hose shall be rated for 1250 deg F for intermittent use, an interior temperature of 1000 deg F and a 600 deg F continuous duty baking test.
4. The side plates shall be drawn securely together and retained by heavy gauge "J" channel steel support braces. These support braces keep the side plates square and solid.

5. The hose reel drum shall be constructed of 16 gauge cold rolled steel. The drum shall be formed and rolled to an 18" diameter and strengthened by four inner support bars. These bars are secured to the drum end flanges and pull the drum tightly against the end flange. The drum end flanges shall be constructed of 16 gauge cold rolled steel. The end flange outer edge shall be rolled to provide strength and rigidity. Each end flange shall have a center pressed 18" diameter groove. This groove allows the reel drum and end flange to mate so the drum's inner support bars draw the end flange securely to the drum.
6. The hose reel shall have a hose to drum connection fitting allowing for use of either 4", 5", 6", or 8" hose. The connection fitting supports an inner 6" or 8" diameter tube that completes the connection from the connection of 6" or 8" diameter discharge duct.
7. The hose reel drum shall also be supplied with a hose tracking bar to guide the hose during the recoiling function.
8. The hose reel function shall consist of a spring cassette housing containing a high carbon drive spring. The activation of the manual extension and spring return is by a Lock and Latch feature. The necessary length of hose desired can be locked in place and the hose is automatically retracted after use.
9. The hose reel functions of uncoiling and recoiling of the hose shall be by direct pulling on the extraction hose. The reel shall have an adjustable hose stop to set the hose at the desired recoiling height. This stop shall be mounted to the extraction hose.
10. The 6" diameter nozzle shall be rubber coated metal with a handle, locking hand damper, metal screen, sleeve and Vise Grip type clamping system.
11. Manufacturer shall be Monoxivent, Car-Mon, Nederman or approved equal.

#### 2.25 FUME EXTRACTION SYSTEM

1. The fume extractor system shall consist of a single exhaust fan, a ducted exhaust network, and individual bench top fume extractor arms.
2. The fume extractor arm shall have a 360° swivel elbow, support flange, jointed elbows of polypropylene with glass fiber reinforcement and knurled adjusting knobs, internal spring support, pre-set joints with wear discs that can be adjusted if required, thin-walled anodized aluminum arm sections (anodization 10 microns), mini polycarbonate hood at the end of the arm, quiet thermoplastic elastomer damper with positive seal, anodized aluminum damper handle, external rings of polypropylene with glass fiber reinforcements, axial locking rings of polypropylene

with glass fiber reinforcements, stainless steel threaded shaft inside of joints, stainless steel internal spring, swivel bearings of polypropylene with glass fiber reinforcements, aluminum swivel, and aluminum bearings.

3. The exhaust fan shall be a N-Series Fan, centrifugal low pressure blower type with a 16 blade modified radial tip impeller and a direct drive motor.
4. Motors shall be, TEFC with 460V/3ph/60Hz electrics. Blower wheel shall be direct drive operating at 3450 rpm.
5. Blower housing shall be 14 gauge. A polyester epoxy lacquered galvanized sheet metal housing shall provide round outlet for easy flange, pipe or hose connection. Blower shall have dynamically balanced steel plate impeller.
6. All motors shall be continuous duty type and exceed IP54 protection standards.
7. 

Manufacturer:	Model:
Nederman	BT2 plus N <del>40</del> Series fan
Plymo-Vent	KUA
Vent-A-Kiln	Place-A-Vent

#### 2.26 DUST COLLECTOR

1. Dust collector shall be suitable for wood working dust control. It shall be a freestanding weatherproof self-contained unit, mounted on structural frame of heavy gauge steel construction, with fan, filter cartridges, and prewired motors, timer, and starter.
2. Fan shall be rated at 20,054 CFM/10" TSP, and shall be backward inclined blades, TEFC motor, 60 HP, 1750 RPM, 460V/60 Hz/3 phase. Fan wheel shall be non-sparking. Under normal operation the fan will be operating at 18,000 cfm.
3. Filter section shall have hinged access door(s) for walk-in to filter section. Filters shall be Polyester bags, 8" dia. (washable) by 7' long, and shall have filter shaker rack and two TEFC 1 HP motors with gear reducers. Shaker motor drive(s) shall be located inside filter section on clean air side. Sprinkler head and connection shall be provided in filter cabinet. An inlet backdraft damper shall be provided.
4. Hopper below filter section shall contain minimum 1,000 cubic feet of storage. Unit shall have manually operated discharge slide gate, 42" x 42", for truck waste removal.

5. Unit shall be constructed with a structural steel frame, complete with all required platforms and railings, OSHA guards and a safety ladder. Unit shall be prime and finish painted at the factory.
6. Unit shall be provided with pre-wired control panel, mounted in NEMA 4 enclosure. All wiring shall be terminated on terminal blocks, with matching terminal blocks and knockouts for external field-provided power and control wiring.
7.     Manufacturer:            Model/Series:  
          Kraemer                    Type A, Arrangement 1 or acceptable equivalent.  
          AAF                        Millennium  
          Torit                        Baghouse

2.27    SOUND ATTENUATORS

1.     Outer casing of 22 gauge stainless steel and to shall be continuously welded.. Lock formed seams, mastic filled. 26 gauge perforated stainless steel interior partitions.
2.     Filler material: No media
3.     Seal joints airtight in the field. Casing shall not fail structurally when subject to 8.0 inches internal static.
4.     Provide mating flanges for connection to ductwork.
5.     Submit certification of acoustical performance from an independent testing laboratory.
6.     Performance: Refer to plans for schedule of attenuator characteristics.
7.     Manufacturer:  
          Industrial Acoustics  
          Aerosonics  
          Vibro-Acoustics

2.28    AIR PURIFIERS (COSMETOLOGY)

1.     Cabinet: 18 gauge steel, polyurethane powder painted outside and inside.
2.     Blower: High performance, UL certified for US and Canada
3.     Electrical: Remote speed control with 7'-0" long cord and 7'-0" long power cord with plug.
4.     Noise Level:   58-60 dBA @ 6'-0"  
                          59-61 dBA @ 12'-0"

5. Filters
  - a. Prefilter: Multi-Density Polyester Panel
  - b. Primary Filter: High efficiency rigid cell
  - c. Final Filter: Polyester panel impregnated with activated charcoal
  - d. Neutralizer: Non-woven fiber element impregnated with an odor neutralizing compound.
6. Provide low profile caster base.
7. Manufacturer: Air Impurities Removal Systems, Inc or approved equal.

### PART 3 - EXECUTION

#### 3.01 GENERAL

1. Install equipment in conformance with manufacturer's recommendations.
2. Provide adequate service access and clearances around roof top equipment as per 2003 IMC section 306.5.

#### 3.02 WARRANTY

1. The contractor shall provide to the owner an equipment warranty of no less than 18 months. The warranty period shall begin at the time of substantial compliance of a given phase as provided by the commissioning agent. The contractor shall refer to the phasing documents for installation and start of equipment.
2. The contractor shall furnish and install parts and labor as required for maintenance during the Warranty period.

#### 3.03 MAINTENANCE

1. The contractor shall maintain the air handling equipment during the warranty period. Air handling equipment shall include items listed in this specification and, vav and fan powered units, cabinet unit heaters, exhaust fans etc. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install parts and labor during the warranty period at no additional cost to the owner. The contractor shall change the filters every 60 days.
2. The contractor shall maintain the air handling equipment until the project completes the last phase of construction. Refer to the phasing documents for time durations. The maintenance shall be in accordance with manufacturers recommendations. The contractor shall furnish and install the required maintenance of the equipment at no additional cost to the owner.



3. The maintenance shall include but not be limited to monthly greasing, equipment checks, 60 day filter changes (filters as specified), motor belts, coil cleaning every 6 months, phasing test for the addition of new equipment and piping, and cleaning.

END OF SECTION

SECTION 26 00 00 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Division shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this Division as shown on the drawings, as specified herein, and/or as required by job conditions.
2. This Section 260000 governs general procedures, materials and workmanship as applicable to the electrical work specified in the other Division 26 sections. Refer to Division 1 sections for additional general requirements.
3. Refer to specification Section 019100 General Commissioning Requirements. The Commissioning services for Division 26 systems are specified within Section 019100. The General Contractor, the GC's Subcontractors and the Division 26 Contractor shall include all manpower, time, parts, labor, and resources required to accomplish the commissioning as specified.
4. The contractor shall refer to Specification 01010 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that they remain active during the construction and renovation of the phased project. The contractor shall be responsible for the relocation of infrastructure as required.
5. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be without the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.
6. Due to the phasing of this project the contractor shall provide all tie-ins, live or otherwise required to provide functional systems for this project.
7. Perform the work in accordance with the requirements and provisions of applicable codes and laws.
8. Equipment, materials, and installation shall conform to applicable standards and requirements of the following organizations and documents:
  - ANSI - American National Standards Institute
  - ASTM - American Society for Testing and Materials
  - AWS - American Welding Society
  - CBM - Certified Ballast Manufacturers Association
  - CSA - Canadian Standards Association
  - ETL - ETL Testing Laboratories
  - FCC - Federal Communications Commission
  - FM - Factory Mutual
  - FS - Federal Specifications

ICEA	-	Insulated Cable Engineers Association
IEEE	-	Institute of Electrical and Electronic Engineers
IESNA	-	Illuminating Engineering Society of North America
NEC	-	National Electrical Code
NECA	-	National Electrical Contractors Association
NEMA	-	National Electrical Manufacturers Association
NESC	-	National Electric Safety Code
NETA	-	International Electrical Testing Association
NFPA	-	National Fire Protection Association
OSHA	-	Occupational Safety and Health Administration
UL	-	Underwriters Laboratories, Inc.

#### 1.02 INTENT

1. It is the intention of the specifications and drawings to obtain finished work, clean, tested, and ready for operation.
2. Items and services not shown on drawings, but mentioned in specifications, or vice versa, or items and services necessary to render the work complete and ready for operation, even if not specified, shall be provided without additional cost.
3. Where conflicts occur between drawings and specifications, or within either document, the Contractor shall ask for and obtain a written clarification from the Architect prior to submitting his bid. Otherwise, the items or arrangements of superior quality, greater quantity or higher cost shall prevail and be included in the contract price.
4. The drawings show, among other things, the intent of the system components and routing. Some fittings and accessories are shown, but it is not the intent to show all the fittings and accessories that will be required in order to install the systems in a coordinated way, as finished work. The contractor shall include all fittings and accessories as may be required in order to accomplish the coordination of the various building systems, to ensure the systems fit within the spaces provided.

#### 1.03 WORK INCLUDED

1. The work under this Division shall include labor, material, equipment, services and administrative tasks required to complete and make operable the electrical work shown on the drawings and specified herein, and including, but not limited to, the following:
  - a. Preparation and submission of shop drawings, diagrams and illustrations.
  - b. Procuring necessary permits and approvals, and paying required fees and charges in connection with the work of this Division.
  - c. Coordinating with, and complying with requirements of, the local electric utility, telecommunications service provider, and other franchised utility and service companies as applicable to the scope of this work.
  - d. Record drawings.
  - e. Operating and maintenance instructions and manuals.

- f. Identification labels, tags, charts and diagrams.
- g. The contractor shall visit the site and review the extent of removals with in the complex as it relates to demolition and removals noted in the documents. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The intent of the documents is the removal of existing equipment and infrastructure either noted by the documents or located in the field at no additional cost to the owner. The contractor shall be responsible for the removal of equipment, piping, supports, wiring, etc. and infrastructure not being reused. Refer to specification 260050 for additional scope and criteria.
- h. The contractor shall visit the site and review the extent of relocations with in the complex as it relates to demolition and removals noted in the documents. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The contractor shall be responsible for the relocation of infrastructure as required, either noted by the documents or located in the field, at no additional cost to the owner.
- i. Final connections to electrical equipment and devices.
- j. Cutting, drilling, and patching required for the work of this Division.
- k. Excavation and backfill for underground electrical work.
- l. Concrete housekeeping pads for floor-mounted electrical equipment.
- m. Temporary light and power for construction purposes.
- n. Maintain existing life safety systems in operation during construction.
- o. Testing and adjustment of systems and equipment furnished, installed, and/or connected under this Division.

#### 1.04 APPROVALS

- 1. See General Conditions and Division 1 sections, in addition to the following requirements.
- 2. Submit for approval a list of manufacturers of equipment proposed for the work. Contractor's intent to use exact make specified does not relieve him of responsibility for submitting such a list.
- 3. Where any specific material, process or method of construction, or manufactured article is specified by name or by reference to catalog number of a manufacturer, or other standards, the intent is not to take precedence over the basic duty and performance specified, noted on drawings, or as required for intended results. The Contractor shall verify the duty specified with the specific characteristics of the equipment offered for approval.
- 4. If material or equipment is installed before it is approved, the Contractor shall be liable for its removal and replacement with no additional cost.

1.05 COORDINATION WITH OTHER TRADES

1. Prepare complete set of drawings showing necessary slab openings, cuts or holes in structural members and structural supports that require structural framing. Drawings shall clearly indicate sizes and location relative to established column lines. Drawings shall be made using the latest backgrounds available from the architect. Drawings shall be completed in sufficient time to allow for structural steel fabrication so as not to delay project schedule.
2. Shop drawing submissions shall demonstrate knowledge of the work of other trades, and shall show the locations of the work of other trades that affect the work of this contract.

1.06 COORDINATION DRAWINGS

1. Coordination drawings shall be completed as required in Division 1. Refer to Section 230000 for requirements and sequence of drawing development.
2. The electrical contractor shall add electrical work on the coordination drawings. Electrical work to be shown on the coordination drawings shall include, but not be limited to, panelboards, switchgear, transformers, motor control centers, variable frequency drives, and cable tray and conduit 2" and larger. Additional electrical work shall be shown on coordination drawings where close coordination is required. Access requirements shall be shown for equipment.
3. After other trades have included their work on the coordination drawings and noted conflicts, the trades shall meet to resolve conflicts and agree to acceptable solutions. Each trade shall sign coordination drawings. Items not shown on the coordination drawings are the responsibility of the omitting contractor and the contractor is subject to additional costs incurred by other trades.
4. The Architect and Engineer are not part of the coordination drawing process. The Engineer will provide assistance relative to acceptability of proposed installations to resolve conflicts.
5. Submit final signed coordination drawing to engineer. Only submit items that are different from previously approved shop drawings. Revisions shall be clearly indicated.
6. Any work fabricated or installed prior to sign off by the applicable trades shall be removed and re-installed in conformance with coordination drawings.
7. The overall coordination of the coordination process is the responsibility of the general contractor.

1.07 SUBMITTALS

1. Shop Drawing Schedule
  - a. The Contractor shall submit, within 30 days of the award of his contract, a schedule of proposed shop drawing submissions.

- b. The schedule shall include the following information.
    - 1) Item to be submitted
    - 2) Date of submission
    - 3) Latest date for approval
    - 4) Manufacturers of the specified item.
  - c. Items not specifically listed as "approved equal" should be listed for consideration at this time.
2. See Division 26 equipment sections for specific submittals required. Unless otherwise indicated, submittals are required for electrical devices, equipment, and systems including basic construction materials such as conduit, 600 volt building wire, and standard fittings and boxes.
3. Manufacturers' Data
- a. If catalog cuts of standard manufactured items show different types, options, finishes, performance requirements, or other variations, those features that the Contractor proposes to furnish shall be clearly identified. If any variations from the catalog description are proposed or required, such variations must be clearly noted on the cut.
4. Shop Drawings
- a. Shop drawings shall clearly indicate details, sectional views, arrangements, working and erection dimensions, kinds and quality of materials and their finishes, and other information necessary for proper checking and for fabrication and installation of the items, and shall include information required for making connections to other work.
  - b. Shop drawings shall be numbered consecutively, and drawings related to various units comprising a proposed assembly shall be submitted simultaneously so that such units may be checked both individually and as an assembly.
  - c. Contractor shall keep on the site, in good order, a complete up-to-date set of approved shop drawings. Shop drawings shall be made available for inspection by the Architect.
  - d. The approval of shop drawings will be for general conformance to drawings and specifications, and shall not be construed as permitting any departure from the contract requirements. If the shop drawings show any variations from contract requirements because of standard shop practices or other reasons, such variations shall be clearly identified on the drawings or specifically noted in the letter of transmittal, in order that, if acceptable, suitable action may be taken for proper adjustment in other work affected thereby. If the Contractor fails to so identify such variations, he will not be relieved of responsibility for executing the work in accordance with the contract, even though such shop drawings have been approved and the work installed. Approval shall not relieve the Contractor of responsibility for any error in details, dimensions, etc. that may exist on shop drawings, nor for the

furnishing of materials or work required by the contract and not indicated on the shop drawings. Approval shall not be construed as approved departure from details or instructions previously furnished by the Architect.

- e. No work for which shop drawings are required shall be executed until the Architect's approval is obtained.
5. Submittals will be reviewed for conformance with the contract drawings and specifications. The engineer's review stamp will be affixed to submittals. One of the following actions will be taken.
- a. **NO EXCEPTION** - Submittal appears to comply with the contract drawings and specifications. Contractor is not relieved of responsibility to meet the requirements of the contract drawings and specifications due to errors, omissions, or conflicts with other equipment or trades.
  - b. **EXCEPTIONS AS NOTED** - Submittal appears to comply with the contract drawings and specifications except for the items noted by the engineer. Contractor is not relieved of responsibility to meet the requirements of the contract drawings and specifications due to errors, omissions, or conflicts with other equipment or trades.
  - c. **REVISE AND RESUBMIT** - In the opinion of the engineer the nature and/or quantity of exceptions is sufficient to require resubmission to demonstrate compliance. Submittals must be returned within 30 days for contingent acceptance to remain valid. Submittals will become rejected if not returned within 30 days.
  - d. **REJECTED** - Submittal does not comply with contract drawings and specifications.

#### 1.08 RECORD DRAWINGS

- 1. Provide record drawings in accordance with Contract requirements, indicating in a neat and accurate manner a complete record of revisions to the original design of the work. Include changes and an accurate record, on reproductions of the contract drawings or appropriate shop drawings, of deviations between the work shown and the work installed.

#### 1.09 OPERATING AND MAINTENANCE INSTRUCTIONS

- 1. Furnish manufacturers operating and maintenance instructions, parts lists and sources of supply for replacements in accordance with Division 1 - General Requirements.
- 2. Provide the following:
  - a. Complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions, for equipment supplied.
  - b. Bind each set within a common binder. Index and organize with a table of contents, to permit quick and convenient reference.

- c. One day of instruction in operation and maintenance of equipment to Owner's maintenance force. Schedule a 2-week period, convenient to Owner, during which qualified personnel, including manufacturers' technicians and engineers will be available for Owner's instruction.
- d. Master Operating Manual (submit in quadruplicate).
- e. Manufacturer's mechanical and electrical equipment parts list of components of the systems listed on the equipment schedules, control diagrams and wiring diagrams of controllers.
- f. List shall give system number, unit number, manufacturer's model number, and manufacturer's drawing numbers.
- g. Step by step operating instructions for each system including preparation for starting, re-starting after power failure, or re-setting after overcurrent or short-circuit operation.
- h. Maintenance instructions for each type of equipment.
- i. Possible breakdowns and repairs for each type of equipment.
- j. List of nearest local suppliers for equipment.
- k. Manufacturer's literature describing each piece of equipment listed on the fixture, panel and equipment schedules and in the specifications including wiring diagrams and a copy of any applicable test reports.
- l. As-installed control diagrams by the control manufacturer.
- m. Recommended trouble shooting procedures in the event of foreseeable electrical system failure.
- n. Complete "As-Installed" color coded wiring diagrams of systems and electrical motor controller connections.
- o. Copies of the following test reports or study reports:
  - 1) Medium voltage cable.
  - 2) Emergency power system.
  - 3) Dry type transformer.
  - 4) Computer grade isolation transformer.
  - 5) Pad mounted distribution transformer.
  - 6) Lighting control system.
  - 7) Architectural dimming control system.
  - 8) Emergency inverter system.
  - 9) Lightning protection system.
  - 10) Fire alarm system.
  - 11) Clock/program bell system.



- 12) Intercom/public address system.
- 13) Telephone system.
- 14) Thermographic survey.
- 15) Short circuit, arc flash and coordination study with final settings.

1.10 GUARANTEES AND SERVICES

1. Workmanship, installation materials, and equipment shall be guaranteed as specified in the General Conditions and Division 1.
2. Manufacturers' Warranties
  - a. The manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:
    - 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
    - 2) For a period of 18 months from date of acceptance by the Owner or twenty four months from date of shipment, the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, and labor for parts replacement are the responsibility of the installing contractor.
    - 3) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
  - b. The final acceptance of the equipment will be made by the commissioning agent after the manufacturer has adjusted his equipment, tested the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project. Refer to the phasing documents for additional information and criteria.
3. Contractor shall leave entire system installed under this Contract in proper working order, and shall replace any work or material which develops defects within the guarantee period, including other work damaged as a result of such defects, without additional cost.

1.11 PERMITS AND CERTIFICATES

1. Prior to proceeding with any installation, the Contractor shall prepare and submit to the proper authorities for their approval working drawings required by them, and shall give necessary notices, obtain permits, and pay local, state and federal taxes, fees and other costs in connection with this work.

1.12 SHORT CIRCUIT, ARC FLASH AND OVERCURRENT PROTECTION COORDINATION STUDY

1. The equipment manufacturer shall perform and submit for review and approval (1) a short circuit study and (2) an overcurrent protection coordination study in accordance with IEEE "Red Book" Standard 141 for service and distribution equipment supplied, including (3) arc flash hazard calculations per IEEE 1584 and complying with NFPA 70E. The study shall include equipment specified in: Sections 263200 Emergency Power System, 263333 Emergency Inverters, 262413 Switchboards, 262416 Panelboards, 260943 Architectural Dimming Control Systems. Provide a computer generated format similar to SKM Systems Power Tools, EDSA Easy Power or approved equivalent. Study reports shall be reviewed and sealed by a professional engineer with the appropriate seal annotated on the title page. Reports shall include as minimum:
  - a. Short circuit summary.
  - b. Coordination summary.
  - c. Incident energies at each equipment, protective device, bus, and feeder.
  - d. Incident energies at defined working distances.
  - e. Arc-flash protection boundary.
  - f. Required protective flame resistant clothing class for arc flash areas.
  - g. Listing of assumptions.
  - h. One-line diagram(s) of complete system to include:
    - 1) Complete component identification to match project labels
    - 2) Transformer KVA and temperature rise
    - 3) CB/Fuse type, frame & trip
    - 4) Conductor quantity, size and length
    - 5) UL listed component AIC rating, including rating with upstream fuse, if applicable
    - 6) Calculated fault current at each node and labeled on the one-line diagram.
  - i. Short circuit computer program results.
  - j. Analysis of short circuit results including discussion of any problem areas.
  - k. Recommended solutions for any identified problem areas.
  - l. Branch & feeder composite computer generated time current curves for equipment and protective devices in system.
  - m. Analysis of coordination results including discussion of any problem areas.
  - n. Recommended settings of protective devices.
  - o. Appendices with time current curves, UL listings, manufacturer's data, and supporting information used in study.
2. Manufacturer shall document that overcurrent protection devices will perform in accordance with their U.L. listings and ANSI/IEEE Standard 242.
3. The short circuit, arc flash and coordination study shall be included with the submittals for equipment included in the study and as listed above. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.
4. The contractor shall be responsible for final field adjustment of ground fault, overload and short circuit settings of adjustable circuit breakers and replacement of fused devices in compliance with the short circuit and coordination study recommendations.

5. Provide labeling of equipment likely to require examination, adjustment, servicing or maintenance while energized to warn qualified persons of potential electric arc flash hazards in accordance with the results of the study and NFPA 70E.

#### 1.13 LOSS CONTROL SERVICES THERMOGRAPHIC SURVEY REPORTS

1. Perform thermographic survey and inspection of new electrical equipment within one (1) year of installation to include: utility service end boxes, pad mount transformers and medium voltage switches, medium voltage cable terminations and splices, switchboards, sub-distribution switchboards and panelboards, branch circuit panelboards, disconnect switches, transfer switches, fuses and circuit breakers, busway, transformers, cable splices, and equipment terminals as shown on the drawings. Perform thermographic survey of other equipment as indicated on the drawings. Thermographic surveys shall be performed during periods of maximum loading using imaging equipment capable of detecting a minimum temperature difference of 0.1°C at 30°C. Loose connections shall be tightened and re-surveyed to confirm adequate repair. Upon completion of survey, submit a report to include the following:
  - a. Complete description of equipment testing.
  - b. Any discrepancies found.
  - c. Temperature difference between the area of concern and the reference area.
  - d. Probable cause of temperature difference.
  - e. Areas inspected to include inaccessible and unused areas and equipment.
  - f. Load conditions at time of inspection.
  - g. Thermographs and photographs of the deficient area.
  - h. Corrective action recommendations.
  - i. Results submitted in formal bound report.

## PART 2 - PRODUCTS

### 2.01 VIDEO RECORDING

1. The contractor shall provide audio video recordings of training and operation for equipment provided to the project.
2. The recording quality shall be such that the audio is clearly distinguishable with zero background noise, and the video should have a studio quality.
3. A professional videographer shall do the recordings. The format shall be in standard Digital Versatile Disk, DVD.
4. The contractor shall provide audio video recordings of equipment maintenance, as described in paragraphs 2 and 3 above. The recordings shall include the equipment being maintained by qualified personnel, the required maintenance tools, and a step by step technique, both verbally and visually demonstrating how to maintain each piece of equipment in a hands on application.

5. The recordings shall include manufacturer's recommended maintenance items for each piece of equipment provided for the project. The recordings shall also include but not limited to the following: each type of light fixture cleaning, each type of light fixture re-lamping, each type of light fixture re-ballasting, electrical panel cleaning, Lighting system's control points, Generator, Inverter, contactors, relays, occupancy sensor systems, smoke detectors, dimming systems and items associated with equipment provided for the project.
6. The finished recordings shall be compiled into chapters. A binder shall be provided for each finished copy of the recordings. The binders shall be provided with a cover sheet, edge sheet, table of contents, disk holders and the description of each disk's recordings.
7. The contractor shall furnish four copies of the finished recordings. Three to be provided to the owner and one copy to the engineer for record.

## 2.02 MATERIALS, EQUIPMENT AND SYSTEMS

1. Materials and equipment and systems shall be new, bear manufacturer's name and trademark, and comply with applicable standards specified.
2. The UL label shall be borne on each piece of applicable material or equipment.
3. Equipment shall be provided with required hardware for proper installation, assembly, and operation.
4. The descriptions cover basic equipment and operation but not complete details of design and construction. The use of singular in descriptions does not limit the quantities of items to be furnished to provide the operation specified. Furnish equipment required to produce specified performance under installed conditions. Provide trim, enclosures and accessories required to make a complete installation.
5. Follow manufacturers' directions in delivery, storage, protection and installation of equipment and materials. Notify Architect promptly, in writing, of any conflict between requirements of the contract documents and manufacturers' directions, and obtain Architect's written instructions before proceeding with work. Bear any costs to correct deficiencies arising from failure to comply with the manufacturers' directions and instructions.
6. Deliver equipment and materials to the site and store in original containers, suitably sheltered from the elements. Store items subject to moisture damage in dry, heated spaces. Tightly cover and protect equipment against dirt, water, chemical, and mechanical injury, and against theft.
7. Equipment and materials of the same general type shall be of the same manufacturer, make and model throughout the work to provide uniform appearance, operation and maintenance.
8. Where new products or components are indicated to be installed or connected to existing systems or equipment, verify compatibility and performance with the manufacturer of the existing systems or equipment prior to purchase and installation.

2.03 EQUIPMENT DEVIATIONS

1. Contractor shall use the specified manufacturers. Any requests for substitutions, including 'or pre-approved equals', must be submitted in writing ten (10) working days prior to the bid due date. Substitutions shall be justified on the basis of need, cost or both, as long as there is no identified reduction in quality and that design parameters are met. Acceptance or rejection of a substitution will be issued to bidders as an addendum. Substitutions will not be accepted after the Bid Date unless requested by the Engineer. Note: Considering a manufacturer as an 'or pre-approved equal' is considered a substitution. Refer to 260000 2.02 E.
2. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, and which requires any additional utilities or redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical or electrical layouts, such redesign and new drawings required thereby, with approval of the Architect, shall be prepared by the Contractor without additional cost. Any changes in the project required to support alternates or substitutions shall be fully identified and submitted on the shop drawings for the substitute or alternate product. Such changes shall be reflected in the coordination drawings and shall be approved by the affected trades.
3. Where such approved deviation requires a different quantity or arrangement of equipment from that specified or indicated on the drawings, the Contractor shall provide any structural supports, controllers, motors, starters, wiring, conduit, and any other additional equipment required by the deviation, at no additional cost.
4. It is the intent of these specifications that wherever a manufacturer of a product or a catalog number is specified, and terms "or pre-approved equal" are used, a substituted item must conform to the specified item. Refer to specification section 260000 2.2A. Consideration will not be given to claims that a substituted item meets performance requirements with lesser construction. Performance as indicated in schedules and in specifications shall be interpreted as minimum acceptable performance.
5. The engineer shall be paid a minimum fee of five hundred dollars for the first four hours and two hundred dollars an hour for every hour over four, for each item submitted for substitution consideration. Payment shall be in advance by the contractor proposing the substitutions.

2.04 ACCESS DOORS IN WALLS AND CEILINGS

1. At each electrical component requiring access when located above ceiling or inside the wall not accessible by removal of grille, ceiling tile or from the air shafts, furnish access panels for installation by trades responsible for wall and ceiling construction as specified under Division 8 – Access Doors and Panels. Size panels sufficiently to access products requiring inspection, maintenance and adjustment, including but not limited to electrically operated valves, in-line controls, fire dampers, instruments and smoke or heat detectors.
  - a. Minimum size for panels: 16 by 16 inches.
  - b. Size panels located in masonry walls to match masonry coursing.

2. Locations: Locate panels in walls and non-accessible ceilings of closets, storage rooms and other non-public spaces to the greatest extent possible. When access panels are required in corridors and public spaces, locate panels as directed by Architect.
3. Panel type and materials: As specified under Division 8.

### PART 3 - EXECUTION

#### 3.01 SITE INVESTIGATION

1. Examine drawings, specifications, and site, and be responsible for the nature and location of work and the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, electric power, roads, etc.

#### 3.02 DRAWINGS

1. Drawings are diagrammatic and indicate the general arrangement of systems and work required. Do not scale the drawings. Consult the Mechanical and Architectural drawings and details for exact locations of equipment.
2. Drawings shall be used in layout of work. Check reference drawings to verify spaces in which work will be installed, and maintain maximum headroom and space conditions. Where headroom, working clearance or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
3. If directed by the Architect, make minor modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

#### 3.03 COORDINATION WITH OTHER TRADES

1. Closely schedule the work so that the work will be installed at the proper time and without delaying the project's completion.
2. Where the work of this Division is to be installed in close proximity to the work of other trades, or where there is evidence that the work will interfere with the work of other trades, assist in working out space conditions to make a satisfactory arrangement. If the work is installed before such coordination with other trades, make necessary changes in the work as directed by the Architect to correct any conflicts or interferences, without additional cost to the Owner.

#### 3.04 COORDINATION AND LAYOUT

1. Study drawings and specifications to ensure completeness of work required. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete the work, even if not explicitly shown or specified.
2. Verify measurements and conditions in field before starting work.

3. Examine materials, surfaces, and structures to which work is to be applied and notify the Architect, in writing, of any conditions that are detrimental to proper and expeditious installation of work. Starting of work shall be construed as acceptance of conditions.
4. Confer with other trades to install work to avoid interference with other trades. The necessary adjustments to conform to structural conditions and work of other trades, particularly ductwork and piping layouts, is included under this section. Assist other trades in the preparation of coordinated layout drawings.

3.05 CONNECTIONS TO EQUIPMENT FURNISHED UNDER OTHER DIVISIONS OR BY OWNER

1. Provide electrical connections to equipment and fixtures requiring such connections which are supplied by Owner or under other Divisions.
2. Provide conduit, wire, lugs, fittings, accessories, and trim for final connection of each item of equipment as required for complete assembly and specified operation.

3.06 WORKMANSHIP

1. Perform work in practical, neat, and workmanlike manner, with electricians skilled in the work they are performing, and using the best generally recognized trade practices.
2. No work shall be covered or hidden from view until it has been inspected and approved by the required Building Department personnel and the Architect.
3. Workmanship or materials not meeting with requirements of the specifications or drawings, or the satisfaction of the Architect, shall be rejected and shall be immediately replaced in an acceptable manner without additional cost.

3.07 TESTS

1. Perform a high potential D.C. test on all equipment and cable rated for use over 600V. Testing on incoming services shall be in accordance with Local Power Company requirements. Tests shall be performed by an approved independent testing Company in the presence of the Architect, Owner, and the local Utility.
2. Notify Architect, in writing, at least one week prior to tests, of the proposed testing timetables. Perform tests with the approval of and in the presence of the Architect or his representative.
3. Provide temporary connections, necessary testing equipment, labor and materials, required for the testing of the systems and equipment. Systems shall be prepared for testing and protected from damage. Measuring instruments shall be properly calibrated. The cost of tests shall be included in the contract price.
4. Verify and correct as necessary the following: voltages, tap settings, trip settings, and phasing on equipment and devices furnished or installed. Secondary voltages shall be tested at the bus in the main switchboard, at panelboards, and at such other locations on the

distribution systems as necessary. Secondary voltages shall be tested under no-load and full-load conditions.

5. Set GFI trip settings as required by the short circuit and protective device coordination study or as directed by the Architect. Initially, prior to final trip settings, set up as follows upon installation:
  - a. Main GFI (no downstream GFI CB): Time at minimum and maximum amp.
  - b. Main GFI (with downstream GFI CB): Time at maximum and maximum amp.
  - c. Downstream GFI: Time at twenty five percent of maximum and amp at twenty five percent of minimum.
6. Electronic solid state trip units shall be set by a manufacturer's trained technician as follows:
  - a. Circuit breakers with solid state trip units shall be initially pre-set to the equivalent LT, LTD, ST, STD setting of the thermal magnetic version of the same ampere rated circuit breaker.
  - b. Instantaneous setting shall be not less than 4X.
7. The ground grid systems shall be tested using the three terminal fall in potential method. A minimum of eight test points for each ground grid system shall be submitted for review by the Architect. The test points shall be made along a straight line from the grid system to the reference terminal. The distance between the grid system and the reference terminal shall be consistent with normal practices for ground testing. Grounding tests shall be performed during the dry season. Tests shall be performed before loaming and seeding or paving work has been performed.
8. Provide a written report on testing and device settings. Include a copy in the Operation and Maintenance Manual.
9. Adjust occupancy sensors for proper operation including time delay, field of view (masking), typed sensing and parallel operation.
10. Test wiring, lighting fixtures, switches, controllers, starters, motors, etc., wired under this Division. Leave free from grounds, crosses, shorts, opens, etc., and leave materials and apparatus in proper and satisfactory working condition. Perform additional tests as listed in the other Division 26 specification sections.
11. Lighting fixtures shall be tested with specified lamps in place for not less than ten hours; the fixtures may be checked in sections.
12. Test for proper operation of emergency lighting equipment under simulated emergency conditions.
13. Test distribution equipment, motors, and three phase receptacles for proper phase connections and phase rotation.
14. Test service entrance, switchboards, panelboards, feeders, branch circuits and receptacles for proper neutral and grounding connections.



15. Prior to energizing, test insulation resistance of conductors and distribution equipment with a 500VDC megger, both phase-to-phase and phase-to-ground. Do not energize any circuits with a reading of less than one megohm (1 million ohms) for #6 AWG wire and smaller or 250,000 ohms for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor. Circuits under megger insulation test shall be connected to respective final terminals but with switches and breakers in the "OFF" position.
16. After fixtures, devices, and equipment are installed and connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and the grounded enclosure and test insulation resistance. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from the neutral bar. He shall then test each branch circuit separately to the panel until the low readings are found. The contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
17. Prior to energizing, test for continuity and identification of each conductor. Identify both ends of each conductor.
18. Perform additional tests required by Owner, Architect or any other authorities having jurisdiction.
19. Correct or replace any circuit, material or equipment that is found to be defective by these tests. Correct defects, whether due to faulty workmanship or material furnished, in a manner acceptable to Architect without additional cost.
20. Notify Architect, in writing, at least one week prior to tests, of the proposed testing timetables. Perform tests with the approval of and in the presence of the Architect or his representative.
21. GFI testing:
  - a. Set GFI trip settings as required by the short circuit and protective device coordination study or as directed by the Architect. Initially, prior to final trip settings, set up as follows upon installation:
    - 1) Main GFI (no downstream GFI CB): Time at minimum and maximum amp.
    - 2) Main GFI (with downstream GFI CB): Time at maximum and maximum amp.
    - 3) Downstream GFI: Time at twenty five percent of maximum and amp at twenty five percent of minimum.
  - b. Electronic solid state trip units shall be set by a manufacturer's trained technician as follows:
    - 1) Circuit breakers with solid state trip units shall be initially pre-set to the equivalent LT, LTD, ST, STD setting of the thermal magnetic version of the same ampere rated circuit breaker.
    - 2) Instantaneous setting shall be not less than 4X.

- c. Electrical tests to manufacturer's original specifications shall include:
  - 1) Contact resistance test.
  - 2) Insulation test: pole to ground, pole to pole, and across open poles.
  - 3) Primary injection test of long time delay at 300% pickup current.
  - 4) Primary injection test of short time delay.
  - 5) Primary injection test of pickup current.
  - 6) Verify trip unit reset.

### 3.08 MAINTENANCE OF EQUIPMENT AND SYSTEM PRIOR TO FINAL ACCEPTANCE

- 1. Maintain all equipment and systems installed until final acceptance by the commissioning agent, engineer, architect, and owner. Maintenance of the equipment shall be the contractor's responsibility until the final phase of the project has been approved by the owner as complete. The contractor shall provide general and manufacturer's recommended maintenance. Maintenance shall include but not be limited to: lubrication, lubricating shafts, belts, hoses, filters (oil, fuel), oil changes, cleaning, coil cleaning, valves (automatic, manual), lighting control system equipment, fire alarm equipment, generator, inverters motors, light fixture lamps and ballasts, etc., and manufacturer's recommended maintenance items. This contractor provides a complete maintenance log for each piece of equipment.
- 2. The contractor shall take such measures as necessary to insure adequate protection of all equipment and materials during delivery, storage, installation and shut-down conditions.
- 3. This responsibility shall include all provisions required to meet the conditions incidental to the delays pending final test of systems and equipment.
- 4. After installation of systems has been completed, refer to the phasing document for additional information, operate the system to determine the capability of the equipment and controls to conform to the requirements of the drawings and specifications prior to performance testing.

### 3.09 IDENTIFICATION

- 1. Equipment
  - a. Identify each item and the system or area it serves. Provide an engraved lamincoid nameplate in a visible location on each switchboard, panelboard, disconnect, switch, motor control center, inverter, automatic transfer switch, annunciator and similar equipment. Provide stencils on major equipment.
  - b. Switchboard devices, panels, cabinets, junction boxes, switches, controllers, etc., shall be identified as to systems, voltage, phases, horsepower, fuse size, circuit breaker size, heater size, magnetic size, and feed location on their exteriors.
  - c. Provide printed labels for all equipment in the system from the project short circuit, coordination & arc flash study file. Assume three (3) labels per equipment/bus in your estimate using 4" x 6" labels or one (1) 6" x 8" label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be

printable directly from the power system software utilized for the study with a Duralabel, Brady PowerMark or GlobalMark printer.

- d. Emergency systems and equipment: Identify all boxes and enclosures, including automatic transfer switches, emergency generators, and panelboards, for emergency circuits with permanent Green color so that they are readily identified as components of an emergency circuit or system as required. Green paint and/or a permanently-affixed nameplate, Green in color with black lettering, shall be acceptable.
  - e. Fire alarm system and equipment shall be identified with permanent Red color so that they are readily identified as components of an emergency life safety system as required. Red paint and/or a permanently-affixed nameplate, Red in color with black lettering, shall be acceptable
2. Wiring
- a. Provide vinyl cloth self-adhering labels for feeders and branch circuits in pull boxes, cabinets, and outlets to identify each feeder and circuit. Manufacturer: Panduit Pan-Code, Brady or approved equal.
  - b. Cables and branch wiring shall be identified showing phasing, system designations, and items served. Identity is required in switchboards, panels, junction boxes, switches, controllers, cabinets, etc.
3. Provide complete, accurate, typewritten panelboard and switchboard directories mounted securely to panelboard doors and switchboard faces. Directories to include for each circuit: room number or area served and load description.
4. Label receptacle cover plates to indicate source panelboard and branch circuit breaker number at bottom of cover plate. Provide typewritten self-adhering labels with black text and clear background, Brady or approved equal.
5. Label covers of pullboxes and junction boxes for systems operating over 600 volts with readily visible lettering at least 1/2-inch high warning "DANGER HIGH VOLTAGE KEEP OUT." Provide warning signs to unauthorized personnel at doors to buildings, rooms or enclosures containing equipment operating over 600 volts.
6. Label covers of pullboxes and junction boxes with readily visible lettering at least 1/4-inch high system, source panel, circuit number and voltage. Provide typewritten self-adhering labels with black text and clear background, Brady or approved equal.
7. Install a permanently affixed sign at the service entrance equipment indicating the type and location of the on-site emergency power source. Install a sign on the main grounding box identifying all emergency and normal sources connected at that location.
8. Provide a reduced size "as-built" single line diagrams, framed under glass, and mounted in a conspicuous place adjacent to the main switchboard.

3.10 CUTTING, ALTERING AND PATCHING

1. Provide cutting, chasing, drilling, altering and rough patching required for the work of this division.
  - a. Including the restoring of existing work cut for or damaged by installation of new work, and where present work is removed.
  - b. Materials and workmanship required in connection with cutting, altering and rough patching shall match the existing work in every respect.
2. Do shoring, bracing, cutting, patching, piecing out, filling in, repairing and refinishing of present work as made necessary by the alteration and the installation of new work.
3. Holes and openings occurring in the existing floors after equipment, partitions, floors, steel work, conduits are removed or installed shall be closed up with materials similar to the adjacent work.
4. The size and location of items requiring an opening, chase or other provisions to receive it shall be given by the trade requiring same in ample time to avoid undue cutting of any new work to be installed. These provisions shall not relieve the Contractor from keeping informed as to the required opening, chases, etc., nor from responsibility for the correctness thereof, nor for cutting and repairing after the new work is in place.
5. Include cutting, repairing and patching in connection with the work that may be required to make the several parts come together properly and fit it to receive or be received by the work of other trades, as shown on the drawings and/or specified, or reasonably implied by the drawings and specifications.
6. Repairing, patching, piecing-out, filling-in, restoring and refinishing shall be neatly done by mechanics skilled in their trade to leave same in condition satisfactory to the Owner.
7. Materials and their methods of application for patching shall comply with applicable requirements of the specifications.
  - a. Materials and workmanship not covered by the specifications and items of work exposed to view adjoining existing work to remain shall conform to similar materials and workmanship existing in or adjacent to the spaces to be altered.
8. Cutting, repairing and patching shall include items shown on the drawings, specified in the specifications or required by the installation of new work or the removal of existing work.
9. Remove partitions, walls, suspended ceilings, etc., as necessary to perform the required alterations or new construction work. Avoid damage to construction and finishes that are to remain.
10. Protect and be responsible for the existing building, facilities and improvements. Any disturbance or damage to the work, the existing building, and improvements, or any impairments of facilities resulting from the construction operations, shall be promptly

rectified, with the disturbed, damaged, or impaired work, restored, repaired or replaced at no extra cost.

11. Alterations which are not indicated on the drawings nor specified herein but necessary to make good existing work disturbed by reason of the work shall be restored to a condition satisfactory to the Owner.
12. Holes in masonry floors and walls are to be core drilled. Scan existing slabs and walls for concealed locations of equipment to include: conduits, piping, rebar and structural elements prior to being core drilled. Prior to core drilling, notify the building occupants of the potential for an unscheduled power outage. The Project Manager shall inspect core holes before installing conduits, sleeves, or poke-through devices. Conduits damaged during core drilling shall be restored immediately at the Contractor's expense.
13. Disturbed concrete and /or cement floor areas shall be patched with approved type latex mortar. When cement mortar is used for patching, the surfaces shall be depressed a minimum depth of 1".
14. Reinstall weather protection work in waterproof manner.
15. Openings in roofs shall be kept properly plugged and caulked, except when being worked on, to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed.
16. Temporary openings cut in walls, floors or ceilings for conduit shall be closed off with non-combustible material except when mechanics are actually working at the particular opening.

### 3.11 SLEEVES AND SEALING

1. Install sleeves of Schedule 40 galvanized steel pipe for conduits and cables penetrating above-grade floor slabs, and any concrete or masonry walls. Sleeves through walls shall terminate flush with wall surface on each side. Sleeves through floors shall terminate 2 inches above finished floor. Neatly and completely grout sleeves in place.
2. Sleeves shall be adequately sized for the conduits and cables to be installed, with sufficient free space to install sealing caulk or putty.
3. Sleeved conduits through slab-on-grade floors, below-grade foundation walls, shafts, and the like shall be provided with sealing bushings to seal against fluid and gas pressure and installed in accordance with UL and manufacturer's instructions.
4. Where penetrating floor slabs and fire-rated partitions, pack the annular space between the sleeves and the conduits and cables with reusable fire-retardant modules, putty, sealant, or caulk. The sealant material shall be intumescent, asbestos free, and installed in accordance with UL and manufacturer's instructions. Sealant materials shall be easily removed and replaced for addition or deletion of cables.
  - a. Penetrations with annular space greater than 1/2" shall be provided with approved backing material.

- b. Fire-retardant sealer and system shall be UL listed for the application and meet ASTM E-84, ASTM E-814, and UL-1479 requirements. Use Hilti Firestop Systems, CSD Sealing Systems, Nelson "FSP", Carborundum Co. "Fyre Putty", 3M "CP-25", IPC "Flamesafe", ROX System or approved equal.
5. Where cable tray penetrates floor slabs, ceilings and rated partitions, the cable tray shall stop approximately 6" from the floor, ceiling or wall. For cable tray 12"x 4", the contractor shall provide (3) 4" metal conduit sleeves provided with connectors and grounding bushings, through the rated floor, ceiling or wall. The cable tray shall then be continued on the opposite side approximately 6" from the floor, ceiling or wall. The cable tray and sleeves shall be grounded and bonded for electrical continuity. The sleeves shall be sealed through the floor, ceiling, and wall. The annular space between the sleeves and the cables shall be packed with reusable fire-retardant modules, putty, sealant, or caulk. The sealant material shall be intumescent, asbestos free, and installed in accordance with UL and manufacturer's instructions. Sealant materials shall be easily removed and replaced for addition or deletion of cables. The contractor shall maintain the floor, ceiling and wall rating.
6. Contractor shall photographically document that proper sealing bushings, fire stopping and sleeving have been performed before locations are hidden from view. Refer to Section 260500 for additional information.

### 3.12 TEMPORARY LIGHT AND POWER

1. Contractor shall furnish, install and maintain a temporary light and power system to provide the buildings, field offices, and project site with temporary light to provide safe working conditions throughout, interior and exterior, and to supply construction power as required on the job.
2. The system shall be furnished, installed, and operating at the earliest possible date.
3. Work for the system shall be in accordance with NEC Article 527, the requirements of the Utility Company, and as approved by the Owner and authorities having jurisdiction.
4. The work shall include generally, but not be limited to, the following:
  - a. Make arrangements with the utility company or the Owner to furnish and install the temporary light and power service.
  - b. Review and coordinate the electrical needs of other trades on a continuing basis, until permanent power and light is available and the temporary system is removed and no longer needed.
  - c. Furnish, install, and maintain required temporary system equipment, devices, and wiring. Remove when no longer needed, or at the direction of the Owner. Modify, add, or relocate equipment, devices, and wiring as required to suit job conditions.

### 3.13 PLENUM APPLICATION

1. Space above the hung ceilings shall not be used as a return air plenum (air transfer), except where specifically indicated on the mechanical drawings and/or other drawings. Material in

spaces so noted shall be suitable for use in plenum application. In spaces so noted, no combustible materials shall be used. Wiring shall be in conduit, or shall be listed for the use, and shall comply with the requirements of NFPA 70, Section 300-22, as well as other applicable codes. Materials used in plenum spaces shall have flame spread/smoke developed ratings as required by code and/or authorities having jurisdiction.

3.14 RENOVIATION OF AREAS NOT IN PRESENT PHASE OF PROJECT

1. In unrenovated areas (areas not in the present phase of work) that will require any kind of work, including but not limited to the installation of new pipe, ductwork, and/or conduit entering, penetrating and/or passing through due to the phasing of the project, this contractor shall be responsible for the covering, moving, relocation, replacing and protecting of the Owner's property. The Owner's property shall include but not be limited to furniture, equipment, furnishings, walls, floors and ceilings. This contractor shall be responsible for the cleaning of the room to the level and condition that the room was prior to the commencement of work. A representative of the Owner shall review the existing condition of the room prior to work commencing. The cleaning shall include the wiping of and/or washing of walls, floors, counter tops, desktops and any and all surfaces that are affected by the installation. After the work has been completed, the Owner's representative shall provide confirmation that the room has been cleaned to the level that it was prior to the work commencing. This contractor shall be responsible for the moving, relocation and putting back in place any and all equipment that will be in the area of work. If this contractor does not clean the room to the level to which it was found, the contractor shall pay any and all costs associated with the room clean-up. If this contractor does not put back in place any and all equipment that will be in the area of work, the contractor shall pay any and all costs associated with the room set-up.

END OF SECTION

SECTION 26 00 50 - DEMOLITION AND REMOVALS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this Section as shown on the drawings, as specified herein, and/or as required by job conditions.
2. The contractor shall refer to specification 01010 for timing and phasing coordination. It is the intent of the documents that the contractor coordinate systems, so that they remain active during the construction and renovation of the phased project.
3. The contractor shall visit the site and review the extent of removals with in the complex. The intent of the documents is removal of the existing equipment and infrastructure either noted by the documents or located in the field at no additional cost to the owner. The contractor shall be responsible for the removal of equipment, boxes, piping, supports, wiring, outdated cabling and infrastructure for systems not being reused.
4. The contractor shall visit the site and review the extent of relocations with in the complex as it relates to demolition and relocations as noted in the documents. The contractor shall also refer to the architectural documents for the additional locations of demolition, removal, and relocation. The contractor shall be responsible for the relocation of infrastructure as required, either noted by the documents or located in the field, at no additional cost to the owner.
5. Mechanical, Electrical, Plumbing, and Fire Protection removals shall be performed during each phase of the project. Occupied areas shall be operational for the use by the owner at all times during the project. At no time shall the area be with out the required Mechanical, Electrical, Plumbing, and Fire Protection services. The contractor shall provide all temporary connections to maintain these services.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.

1.03 SYSTEM INTERRUPTIONS

1. The existing base building facility will be occupied and in operation during the performance of the Work.
  - a. When necessary to temporarily disconnect any existing feeder or branch circuit supplying occupied facilities, confer with the Owner and schedule a mutually agreeable period of interruption.



- b. Where replacement, relocation or modification of existing equipment is indicated, provide and maintain temporary feeders, connections, circuit protection, and any other materials and appurtenances required to maintain services to occupied areas.
  - c. Temporary Fire Alarm: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-alarm facilities of the types needed to protect against reasonably predictable and controllable fire losses.
  - d. The existing building will be in operation throughout construction. The existing fire alarm system shall remain in operation until the new system has been installed and tested. The existing fire alarm system shall be removed completely following acceptance of new system.
2. No work shall be left incomplete, nor any hazardous situation created, which will affect the life or safety of the public and/or building occupants. At no time shall the work interfere with or cut off any of the existing services without the Owner's prior written permission. Do not tamper with fire protection devices including covering smoke detectors or turning off sprinkler valves. Work that may cause a trouble or alarm condition on the fire alarm system or sprinkler system (dust, sprinkler flow, heat, electrical work, etc.) shall be performed only after temporarily shutting down the respective life safety system. Shut downs shall be arranged and scheduled at least 24 hours in advance and coordinated with the Owner and Construction Manager and the Office of the Fire Marshal.
  3. The Owner reserves the right to operate existing electrical and mechanical equipment not included in this work, and to perform required servicing and repairs to same, at all times.
  4. The work indicated and/or specified shall be carried out with a minimum of interference to the established operations of the Building.

## PART 2 - PRODUCTS

### 2.01 GENERAL

1. Products and materials furnished for the work of this section shall comply with Section 260500 BASIC MATERIALS.

## PART 3 - EXECUTION

### 3.01 EXISTING ELECTRIC WORK AND REMOVALS

1. It is the intent of these specifications to remove existing wiring in the existing building and grounds and replace with new. Existing conduit shall be reused in place only where indicated on the drawings or with specific approval of the Engineer.

2. Remove, reroute or relocate any conduit, wiring, lighting fixtures, outlets, and other electrical items that are laid bare in the course of, or interfere with, the alterations. Remove exposed outlets, conduit and branch circuit work which interfere with the alterations.
3. It is the intention of these specifications to provide for the continuance of electrical services including: power, lighting, telephone, data, fire alarm, and security as presently installed in renovated areas until the replacement services are complete. Provide conduit, wiring, and devices necessary to maintain services to these areas.
4. Compare the plans with the existing conditions to determine the amount of work affected. Remove unused exposed circuit work, outlets, fixtures and the like not required by the alterations.
5. Materials to be removed and not reinstalled under this Division of the Work, unless otherwise indicated, shall become the property of the Contractor and shall be removed from the site.
6. Feeders and branch circuits to be removed: conductors and cables shall be completely removed back to their source. Exposed or accessible conduits shall be removed completely; conduits embedded in concrete or masonry shall be cut off flush and the surface patched smooth and level.
7. All existing low voltage wiring, telecommunications and/or data systems wiring, fire alarm wiring, and security system wiring not scheduled to be reused shall be removed in its entirety as required by NEC Articles 640, 645, 725, 760, 770, 800, 820, and 830. Wiring shall not be abandoned and left in place.

### 3.02 DISPOSAL OF REMOVED MATERIALS

1. Removed materials shall be disposed of using licensed carting service.
2. Hazardous materials including polychlorinated biphenyl (PCB) substances as found in lighting ballasts, mercury contaminated materials as found in fluorescent lamps, and the like shall be disposed of by an EPA and CT. DEP approved, licensed disposal service. Contractor shall obtain and have on file, waste disposal manifest and receipts stating how and where the waste was disposed of or converted.

END OF SECTION

SECTION 26 05 00 - BASIC MATERIALS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions.
2. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.
3. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' catalog data for the following basic materials:
  - a. Surface raceways and fittings.
  - b. Wireway, trough, and fittings.
  - c. Flexible Cable tray and fittings.
  - d. Wire and Cables (MC,).
  - e. Wiring devices and wallplates.
  - f. Floor boxes and fittings.
  - g. Disconnect switches and fuses.
  - h. Circuit breakers.
  - i. Underground line marker tape.
  - j. Surge Protection Devices (SPD).
  - k. Submetering.

- l. Area of Refuge Emergency Call System.
  - m. Bathroom Emergency Call System.
  - n. Electric cord & cable reels.
  - o. Low voltage lighting power supply.
  - p. Pad-mounted distribution transformers.
2. Submit scaled and dimensioned shop drawings for the following:
- a. Custom-fabricated pull, junction boxes, and terminal boxes.
  - b. Exposed raceway installations in architecturally finished spaces.
3. Submit samples of the following:
- a. Wiring device wall plates.
  - b. Wiring devices.

#### 1.05 WARRANTIES

1. Manufacturers' Warranties
  - a. The manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:
    - 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
    - 2) For a period of 18 months from date of acceptance by the Owner or twenty four months from date of shipment, the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, and labor for parts replacement are the responsibility of the installing contractor.
    - 3) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
  - b. The final acceptance of the equipment will be made by the commissioning agent after the manufacturer has adjusted his equipment, tested the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project. Refer to the phasing documents for additional information and criteria.

PART 2 - PRODUCTS

2.01 WIRING & RACEWAY SCHEDULE

1. Except where specialty wiring methods are called for, use wiring methods selected in accordance with the following list. Use threaded rigid steel conduit with wire installed as the wiring method for purposes and in locations not covered by the following list and where the listed wiring methods are excluded.

RACEWAY & WIRE	APPLICATION
Threaded Rigid Steel Conduit	Mechanical, electrical, generator, and elevator machine rooms and shafts; fire pump, jockey pump, smoke exhaust fan feeders, and associated control circuits; exposed outdoors, roofs, stub-ups, or penetrations through concrete slabs or equipment pads; circuits above 600 volts.
Electrical Metallic Conduit (EMT)	Interior, dry locations for: switchboard, panelboard and motor control center feeders, branch feeders, lighting and appliance circuitry; homeruns to overcurrent protection device; fire alarm (Section 283100), telecommunications (Section 270528 IT consultant specifications sound & video and security consultant /vendor specifications).
Rigid Non-metallic Conduit	Below grade, below slab – Schedule 40; Outdoors where exposed to physical damage and in corrosive locations where shown on drawings – Schedule 80; encased in concrete, concrete ductbanks - Type EB (Encasement Burial).
Flexible Metal Conduit	Final connections minimum 18 inches and less than six (6) feet only for lighting and appliance branch circuitry in accessible voids of suspended ceilings; final connections minimum 18 inches and less than three (3) feet to motors in mechanical rooms, other interior dry locations, or where located in plenums or other spaces used for environmental air. Provide grounding conductor.
Liquidtight Flexible Metal Conduit	Final connections minimum 18 inches and less than three (3) feet only for lighting and appliance and motor branch circuitry in exposed wet or damp locations. Do not use in plenums or other spaces used for environmental air. Provide grounding conductor.
Metal Clad Cable (MC)	Lighting and appliance branch circuitry concealed in dry wall partitions and accessible voids of suspended ceilings and concealed spaces except homeruns to overcurrent devices which shall be EMT.

Optical Fiber/Communications Cable Raceway	Inner duct for communications applications in conduit or ductbank.
Surface Metal Raceway	Exposed work in finished areas only where specifically indicated on drawings or approved by the Architect. Exclude in concealed locations.
Surface Nonmetallic Raceway	Exposed work in finished areas only where specifically indicated on drawings and approved by the Architect. Exclude in concealed locations.
Flexible Cable Tray	Low voltage, voice, data and video systems in exposed locations and above accessible ceilings.
Mineral Insulated, Metal Sheathed Cable (MI) or Type RHH in Conduit – 2 Hour Rated	Exposed elevator and emergency lighting and appliance circuits where specifically indicated on drawings.

2. Minimum raceway size: 3/4-inch. Exception: Provide minimum 1-inch below grade or below slab on grade locations and unless otherwise noted.
3. Provide equipment ground conductor per 3.04.

## 2.02 RACEWAYS

1. Provide raceways of the types and sizes indicated and specified, or as required to comply with codes and job conditions where not so indicated or specified.
2. Metallic Conduit, Tubing, and Fittings
  - a. Rigid steel conduit shall be hot-dip galvanized, conforming to ANSI C80.1, UL 6, and NEC Article 344. Fittings and couplings shall be threaded. For outdoor locations provide raintight conduit hubs with insulated throat and bonding screw equal to O.Z. Gedney Type CHM-T. Die-cast fittings are not acceptable.
  - b. Electrical metallic tubing (EMT) shall be galvanized steel, conforming to ANSI C80.3, UL 797, and NEC Article 358. Provide with galvanized steel compression type fittings, couplings, and connectors for sizes less than 1-1/2 inch. Provide with galvanized steel double set screw type fittings, couplings, and connectors for sizes 1-1/2 inch and larger. Die-cast fittings are not acceptable. Die-cast “snap-in” type fittings are not acceptable.
  - c. Liquidtight flexible metal conduit shall have an interlocked flexible galvanized steel core with a permanently bonded polyvinylchloride (PVC) jacket, conforming to UL 360 and NEC Article 352. Die-cast fittings are not acceptable.
3. Flexible metal conduit shall be interlocked flexible galvanized steel conforming to UL 1 and NEC Article 348. Die-cast fittings are not acceptable.

4. Connectors for metal conduit shall be insulated throat type. Provide galvanized steel grounding bushings or locknuts at metallic raceway connections to sheet steel boxes and enclosures. Die-cast fittings are not acceptable.
5. Connectors for metal conduits which contain BOTH normal ground AND isolated-ground conductors, where the conduit is NOT being used as the equipment grounding conductor, shall be phenolic insulating types. O-Z Gedney Type ICC or approved equal. (For conduits containing only a normal ground conductor or only an isolated ground conductor, where the conduit is also used as the equipment grounding conductor, provide galvanized couplings and connectors as specified above.) Die-cast fittings are not acceptable.
6. Expansion fittings for metal conduit shall be as follows:
  - a. Rigid metal conduit in air: Provide 4-inches conduit expansion and contraction allowance; O.Z. Gedney Type AX or approved equal by Allied or Metallic.
  - b. Rigid metal conduit in concrete or wet locations: O.Z. Gedney Type DX or approved equal.
  - c. EMT conduit in air: Provide 4-inches conduit expansion and contraction allowance; O.Z. Gedney Type TX or approved equal by Allied or Metallic.
7. Non-Metallic Conduit and Fittings
  - a. Schedule 40 and Schedule 80 rigid non-metallic conduit shall be polyvinyl chloride (PVC), rated 90 degrees C., conforming to NEMA TC-2, UL 651, and NEC Article 352. Provide with matching fittings conforming to NEMA TC-3 and UL 514.
  - b. Type EB (Encasement Burial) Schedule 20 non-metallic conduit shall conform to NEMA TC-6, ASTM F-512 and UL 651A. Provide with matching fittings conforming to NEMA TC-9.
  - c. Expansion fittings for PVC conduit shall be as follows:
    - 1) PVC conduit in concrete or wet locations: O.Z. Gedney Type EX or approved equal by Allied or Metallic.
8. Optical Fiber/Communications Cable raceway and fittings in reel lengths manufactured of high density polyethylene (HDPE). Comply with UL 2024; flexible type, listed for plenum, riser or general purpose. Include factory installed polyester tape. Fittings, cement and accessories shall be from one manufacturer; Lamson & Sessions Carlon Corrugated HDPE or approved equal.
9. Surface Metal Raceway
  - a. Provide two-piece surface metal raceway of the types, sizes, and configurations indicated, complete with fittings, boxes, devices, covers, plates, mounting straps, etc. as required for a finished installation, in conformance to UL 5 and NEC Article 386.

- b. Provide fittings for flush feed-in unless otherwise indicated or required.
  - c. For multi-service power/telecommunications surface raceways, provide continuous metal divider between compartments.
  - d. Large surface metal raceway and components shall be Hubbell HBLALU3800, 2.10"D x 3.00"H or Wiremold Co., G4000, 1-3/4"D x 4-3/4"H, unless otherwise shown on drawings, or approved equal as manufactured by Mono-Systems, Inc., satin anodized finish.
  - e. Small surface metal raceway and components shall be Hubbell Inc., HBL750 series, or Wiremold Co., V700 series, 3/4"W x 2-1/32"H, unless otherwise shown on drawings, or approved equal as manufactured by Mono-Systems, Inc, ivory color. Use for exposed work in finished areas only where specifically indicated on drawings and approved by the Architect. Exclude in concealed locations.
  - f. Provide metal raceways with factory installed conductors and attachment plug receptacles. Receptacles shall be specification grade, 15 ampere, 125 volt mounted 6inches on center. Do not attempt field installation of additional conductors except where product is so marked.
  - g. Provide multi-outlet assemblies suitable for installation in accordance with Article 353 of the NEC. Fittings shall be manufactured by the multi-outlet assemblies manufacturer under UL5. Provide Hubbell Inc. HBL2000 raceway, HBL2000 Plug Trak or Wiremold G2000 raceway, 2000 Plugmold and matching fittings in ivory color or approved equivalent by Mono-Systems, Inc. Where indicated to serve audio systems, provide Wiremold 2000 IG series and label "Audio Only – Technical Power."
10. Wireways and Troughs
- a. Provide factory-fabricated sheet metal wireways and troughs of the types, sizes, and configurations indicated, or as required to suit job conditions, complete with fittings, connectors, end plates, hangers, etc. as required for a finished installation. Products shall be galvanized steel with ANSI 61 gray acrylic electrocoat finish. Fittings and components shall conform to UL 870 and NEC Article 376.
  - b. Wireways, troughs, and components shall be as manufactured by Square D, Hoffman Engineering Co., Wiegmann & Co., or approved equal.
11. Flexible Cable Tray
- a. Provide flexible cable trays for low voltage, voice, data, and video wiring, of the sizes and configurations indicated, complete with fittings, connectors, hangers, etc. as required for a finished installation to Category 6A UTP standards.
  - b. Unless otherwise indicated, flexible cable trays shall be welded wire mesh permitting continuous ventilation of cables. Provide straight sections in 118-inch



lengths suitable for field bending and fitting to cable pathway contours. Minimum tray width shall be 18-inch by 6-inch depth.

- c. Finish: Wire to be welded, bend and surface treated after manufacture. Surface finish to be hot dip galvanizing in molten zinc bath providing an average coating thickness of 2.4 mils to 3.2 mils, where used outdoors; electro-plated zinc galvanizing where used indoors.
- d. Fittings: Cable management fittings to be field manufactured from straight sections through the use of hardware and instructions supplied by the manufacturer. Fasteners and hardware shall be stainless steel.
- e. Installation: Cable management system to be installed using splice connectors and support components as supplied by the manufacturer. Provide support components for side supports. Do not use center support style. Furnish and install in the DATA/IDF, IDF, and DATA rooms no less than 40' per room of 18-inch by 6-inch depth cable tray to be coordinated with tele/data cable entry and equipment racks and as noted on the documents. Coordinate with telecommunication consultant.
- f. Penetrations: Where cable tray penetrates floor slabs, ceilings and rated partitions, the cable tray shall stop approximately 6" from the floor, ceiling or wall. For cable tray 18"x 6", the contractor shall provide (4) 4" metal conduit sleeves provided with connectors and grounding bushings, through the rated floor, ceiling or wall. Refer to detail #2 on drawing E-701. The cable tray shall then be continued on the opposite side approximately 6" from the floor, ceiling or wall. The cable tray and sleeves shall be grounded and bonded for electrical continuity. The sleeves shall be sealed through the floor, ceiling, and wall. The annular space between the sleeves and the cables shall be packed with reusable fire-retardant modules, putty, sealant, or caulk. The sealant material shall be intumescent, asbestos free, and installed in accordance with UL and manufacturer's instructions. Sealant materials shall be easily removed and replaced for addition or deletion of cables. The contractor shall maintain the floor, ceiling and wall rating.
- g. Loading: Flexible cable trays shall be designed to support a load of 100lbs./ft. across a 12" span with a maximum deflection of 1.5 inches. In addition, the tray shall be capable of supporting a 200lb. concentrated load at mid-span without damage or permanent deformation.
- h. Flexible cable trays shall be as manufactured by B-Line, G.S. Metals Flextray, Cablofil Inc. EZ Tray, Cope Cat-Tray or approved equal.

## 2.03 SLEEVES

- 1. Furnish and Install (4) 4" sleeves at IDF rooms walls to corridor.
- 2. Furnish and Install (4) 4" sleeves at IDF rooms floors.
- 3. Furnish and install (4) 4" conduits between first floor and second floor IDF rooms.

2.04 600 VOLT WIRE AND CABLE

1. Wire and cable for secondary power and lighting circuits and for NEC Class 1 control circuits shall be fabricated of annealed 98% conductivity copper conductors with 600 volt, 90°C-rated, thermoplastic or cross-linked polymer insulation, manufactured in strict accordance with applicable requirements of UL, NEMA, ICEA and ASTM.
2. Copper conductors No. 10, 12, and 14 AWG shall be solid or concentric stranded Type THHN/THWN-2; No. 8 AWG through No. 1 AWG shall be concentric stranded Type THHN/THWN-2; No. 1/0 AWG and larger shall be concentric stranded Type XHHW-2.
3. Type MC metal-clad cable shall conform to UL 1569 and NEC Article 334, and shall be constructed of minimum No. 12 AWG copper conductors, with THHN insulation, a green-colored insulated ground conductor, and a galvanized steel interlocked armor sheath; provide listed and labeled Type MC fittings. MC cable used for multi-wire homeruns shall contain a single, oversized neutral conductor, sized to accommodate non-linear loads. Provide AFC "Super Neutral Cable", or approved equal. Aluminum armor sheath is not acceptable on this project due to electrical noise mitigation considerations.
4. Bare grounding conductors: See paragraph 2.08 Grounding Materials.
5. Service Cords: Provide heavy duty service supply cable conforming to ICEA S-68-516-NEMA WC-8, UL listed for outdoor use, 90°C EPDM insulation, black jacket; Carol Super Vu-Tron Type W Round or approved equivalent sizes as indicated.
6. Type (MI) Mineral Insulated Metal Sheathed Cable is intended for use in accordance with Article 332 of the National Electrical Code. Terminations shall be screw-on potting fitting type and shall comply with UL 514B and be suitable for 90C in dry locations and 60C in wet locations. Hourly fire rating of MI cable installation applies only to continuous lengths of cable passing completely through a fire zone and terminating a minimum of 12-inches beyond the fire rated wall or floor bounding the fire zone. MI cable shall be Pyrotenax System 1850, or approved equal, and in conformance with the following:
  - a. Mineral insulated (MI), metal-sheathed cable shall be a factory assembly of one or more conductors insulated with highly compressed magnesium oxide insulation and enclosed in a seamless, liquid-and-gas-tight continuous copper sheath suitable for grounding.
  - b. Conductors shall be of solid, high electrical conductivity copper with a continuous copper sheath.
  - c. The insulation shall be of highly compressed magnesium oxide that will provide proper spacing for conductors. Thickness of insulation shall be at least 55 mils for 600 volt power and control cables from 16 AWG to 500 KCM and 23 mils for 300 volt twisted pair cables.
  - d. MI cables and installation shall comply with Article 332 of the NEC and other relevant provisions and articles. MI cable shall be classified by UL as being 2-hour fire resistive.

- e. MI cable shall be specified by outside diameter of the cable in thousandths of an inch and by number of conductors; i.e. 699/1 for single conductor 4/0 AWG cable. Accessories for terminating and installing MI cables shall also be specified by cable reference; i.e. 699/1 Pyropak for single conductor, 4/0 AWG cable.
- f. MI cable support clips shall be maximum 36-inches spacing for horizontal cable runs and maximum 72-inches spacing for vertical cable runs per manufacturer's recommendations and UL listing requirements.
- g. "HVAC Control Cable" shall be 12 strand multi-mode, laser optimized, interlocked, and armored 50 m fiber optic cable. Gigalite-10 armortek bertek part #PDPK012-EB3010/25 or approved equal by Mohawk, or Comscope for runs longer than 150 feet. Use Category 7 cable shall be used for all other remaining HVAC Control Cable requirements.

## 2.05 TERMINATIONS

- 1. Terminations, splices and taps under 600 volts:
  - a. Copper conductors No. 10 and smaller: Provide with copper compression type or twist-on spring-loaded connectors and nylon insulating covering. Connectors for outdoor conductors shall be suitable for direct burial installation.
  - b. Copper conductors No. 8 and larger: Provide hydraulic copper compression type UL 486B listed and pre-filled with antioxidant compound using manufacturer's recommended tooling, Burndy or approved equal; or mechanical bolted pressure type, IlSCO ClearTap or Cytolok spring compression terminator or approved equal. Exception: Wiring terminations rated 100,000 amperes short circuit current and greater shall be provided with compression type lugs.
  - c. Cable lugs and connectors: Provide compression type of tin-plated copper or tin-plated aluminum and dual-rated for copper or aluminum conductors. Provide to match cable, pre-filled with antioxidant compound, UL486B listed, with marking indicating size and type. Where oversized feeders are installed to reduce voltage drop and the equipment terminations are not sufficient to accept the larger feeders, provide the proper equipment terminations or provide Burndy Type YE-series or approved equivalent by IlSCO or Cytolok compression adapters.
  - d. Lug connections to bus bars: Provide with tin plated lugs and Belleville compression washers. Use anti-seize compound on threads.
- 2. Terminations, splices and taps over 600 volts: Refer to Section 260513 Medium Voltage Cable.

## 2.06 ELECTRICAL BOXES

- 1. Provide outlet, junction, pull, and floor boxes, complete with associated fittings and accessories, as indicated and specified, as required by codes, to suit job conditions, and compatible with the associated wiring methods and devices.

2. Interior Outlet Boxes
  - a. Provide galvanized pressed steel boxes of appropriate size and type. Provide each with appropriate plaster ring to suite wall construction.
  - b. Unless otherwise indicated, or required by job conditions, provide boxes as follows:
    - 1) Flush wall power outlets in hollow partitions - 4" square, 1-1/2" deep, with 1- or 2-gang device cover; provide gang boxes for 3 or more adjacent outlets.
    - 2) Flush wall power outlets in masonry walls - 3-1/2" deep masonry boxes, with number of gangs as required.
    - 3) Recessed switches - 3" x 2" x 3-1/2" deep, gangable.
    - 4) Surface mounted power devices - 4" square, 1-1/2" deep, with rounded corners and appropriate raised cover.
    - 5) Flush or surface telecommunications outlets - 4" square, 2-1/8" deep, where 1" knockouts are required; 4-11/16" square, 2-1/8" deep, where 1-1/4" knockouts are required. Device covers shall be provided as required by telecommunications specifications, or Owner's telecommunications vendor.
    - 6) Refer to "Floor Box" product descriptions for specific floor box dimensions.
3. Exterior or Wet Area Outlet Boxes
  - a. Provide corrosion-resistant cast metal raintight boxes with threaded conduit entrance fittings, Myers Scru-Tite hubs or approved equal by Allied or Metallic.
  - b. Covers shall be gasketed PVC, with spring-loaded weathertight-while-in-use covers as appropriate for the application.
4. Utility Power Pedestal
  - a. Provide utility power pedestal with single GFCI receptacle in die-cast aluminum single gang weather-proof outlet box with weather-proof hinged cover. Pedestal shall be welded 14 gauge stainless steel, 2"x2"x48"L, with 16 gauge stainless steel roof flange; 12" below roof flange and 36" above roof flange; NEMA 3R construction. Manufacturer: MAPA Products Model MPX-20-G or approved equal by Hubbell or Bryant.
5. In-ground Cast Boxes
  - a. Provide vehicular traffic bearing galvanized cast iron or cast polymer resin concrete or non-traffic bearing cast fiberglass underground junction and pull boxes for flush mounting as shown on drawings.

- b. Cover shall be non-skid with neoprene gasket and stainless steel cover screws. Cover legend: ELECTRIC, TELEPHONE, CATV and as shown on drawings.
  - c. Manufacturers: Cast iron or aluminum - O-Z Gedney, Crouse-Hinds; Polymer concrete - Quazite or Synertech; Cast fiberglass - PenCell; or approved equivalents.
6. Pull and Junction Boxes
- a. General: NEMA 250, Type 1, galvanized steel, finished inside and out with manufacturer's standard enamel.
  - b. Hinged-Cover Enclosures: Except as noted otherwise, with continuous hinge cover and flush latch.
  - c. Cabinets: Except as noted otherwise, with removable interior panel and removable front. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.
  - d. Outdoors or in wet areas, pull and junction boxes shall be NEMA 3R or NEMA 4 construction.
  - e. Manufacturers:
    - 1) Hoffman Engineering Co.; Federal-Hoffman, Inc.
    - 2) Spring City Electrical Manufacturing Co.
    - 3) Erickson Electrical Equipment Co.
7. Telecommunications Terminal, Outlet and Pullboxes
- a. Outlet boxes shall be galvanized sheet steel as described elsewhere in this Section with exceptions as noted hereafter. Desk type telephone and computer data outlet boxes shall be minimum size 4 11/16" square box with double gang faceplate and plaster ring. Outdoors: Cast boxes, NEMA FB1, Type FD, aluminum. Provide gasketed cover by box manufacturer and threaded hubs.
8. Floor Boxes
- a. Provide floor boxes as indicated, suitable for the application, complete with compatible accessories including, but not limited to: trim rings, device plates, service fittings, tile or carpet flanges and protective rings for mechanical and wet mop protection.
  - b. Floor box fittings shall be equipped with gasketing and shall be constructed to meet or exceed UL scrub water exclusion requirements and be so listed.
  - c. Poke-through fittings shall be UL listed to maintain fire rating of floor construction. Do not use in new slabs unless specifically noted.

- d. Floor boxes shall be cast iron for installation in slab-on-grade floors or wet floors, formed sheet steel for above-grade installations. Coordinate box depth with slab thickness and other job conditions. Boxes shall be adjustable before and after pour.
- e. All floor boxes, regardless of whether poured-in-place or poke-thru types, shall be ADA-approved with regard to height above finished floor and surface slope ratio.
- f. Where new floor boxes are indicated in existing floors, provide required saw-cutting and patching of existing floors as required for flush installation.
- g. Coordinate specific non-power connectivity requirements with the Owner’s Information Technology and Telecommunication System vendors.
- h. Poured-in-place boxes shall be provided in types as follows:

<b>Label</b>	<b>Shape</b>	<b>Trim/Cover</b>	<b>Outlets</b>	<b>Description</b>
Type 3	Square	Brass [Aluminum] [Plastic]	six duplex receptacles and data. Provide with RFB9 hinged cover plate.	Multi-service box for installation in new concrete slabs. Wiremold Series RFB9SL. (4-1/2”D max.) or approved equal by Hubbell or walker.

- 9. Where different voltage systems are indicated to occupy a common box, provide internal metal barriers or dividers between systems.

**2.07 WIRING DEVICES**

- 1. Provide switches, receptacles, connectors, and other wiring devices complete with associated hardware and wall plates, as indicated and specified. Devices of one type (such as switches and receptacles) shall be made by one manufacturer. Acceptable manufacturers are: Hubbell, Bryant, or approved equal by Bryant or ArrowHart.
- 2. Verify device colors and plate materials and finishes with the Architect. Unless otherwise noted, receptacles connected to emergency or standby power shall be “red”; isolated ground receptacles shall be factory embossed with an “orange” triangle.
- 3. Wiring devices shall comply with applicable UL and NEMA requirements and shall be UL labeled for the appropriate NEMA-classified document.
- 4. Local Wall Switches (line voltage type)
  - a. Provide premium specification grade quiet operating AC switches, rated 20 amperes at 120 volts. Switches shall be verified by UL to meet Federal Specification W-S-896E.
  - b. Provide single pole, double pole, 3-way, or 4-way operation as indicated or required.
  - c. Switches shall be approved equal Hubbell 1221 series , or approved equal by Bryant or ArrowHart.

5. Pilot Light Switches, 20 A, Single pole, with neon-lighted handle, illuminated when switch is "ON": Hubbell; HPL1221PL for 120 V and 277 V, Bryant; 1221-PLR for 120 V, 1221-7PLR for 277 V, or approved equal by Bryant or ArrowHart.
6. Key-Operated Switches, 120/277 V, 20 A, Single pole, with factory-supplied key in lieu of switch handle: Hubbell; HBL1221L, Bryant; 1221-2L, or approved equal by Bryant or ArrowHart.
7. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors: Hubbell; HBL1557 or approved equal by Bryant or ArrowHart.
8. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle: Hubbell; HBL1557L, Bryant; 1257L, or approved equal by Bryant or ArrowHart.
9. Duplex Convenience Receptacles
  - a. Receptacles shall be standard NEMA 5-20R configuration
  - b. Receptacles shall be two-pole, three-wire grounding type, with molded nylon body and face, premium specification grade, rated 20 amps at 125 volts. Receptacles shall meet Federal Specification W-C-596F.
  - c. Receptacles shall be Hubbell 5362 series, or approved equal by Bryant or ArrowHart.
  - d. Where 15 ampere rated receptacles are indicated or required, provide Approved equal Hubbell 5262 series or approved equal by Bryant or ArrowHart.
  - e. Weatherproof lockable and flush covers for public outdoor, wet or damp location outlets shall be specification grade enclosures with neoprene gasket seals and mortar tabs for positive holding means and retains weatherproof feature with or without plug inserted. Provide Pass & Seymour heavy duty cast aluminum cover No. 4600 series or approved equal by Bryant or ArrowHart.
  - f. Weatherproof non-locking and flush covers for non-public outdoor, wet or damp location outlets shall be specification grade enclosures with neoprene gasket seals and retains weatherproof feature with or without plug inserted. Provide Taymac Multi-Mac Series or approved equal by Intermatic or Pass & Seymour.
10. Special Purpose Receptacles and Switches
  - a. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 2003 and shall be rated 20 amps with 20 amp feed-through rating, 125 volt duplex, NEMA 5-20R, Hubbell #, Bryant #GR5352 or approved equal by Bryant or ArrowHart. Provide testing of receptacles as to voltage, ground impedance etc. and for GFI receptacles to test for tripping values specified in UL 1436 and UL 943.

- b. Transient voltage surge suppression receptacles shall have integral metal oxide varistors rated: 150 volt rms, 80 joules energy absorption and 6,500 amperes current handling capacity minimum to suppress transients equally in modes; 20 amp, 125 volt, NEMA 5-20R, LED indicator, Hubbell Circuit Guard #HBL 5362-S series or approved equal by Bryant or ArrowHart. Receptacles shall be “orange” in color.
- c. Isolated ground receptacles voltage surge suppression receptacles shall have integral metal oxide varistors rated: 150 volt rms, 80 joules energy absorption and 6,500 amperes current handling capacity minimum to suppress transients equally in modes; 20 amp, 125 volt, NEMA 5-20R, LED indicator, Hubbell Circuit Guard #HBL 5362-S series or approved equal by Bryant or ArrowHart. Receptacles shall be “orange” in color.
- d. Isolated ground receptacles without integral surge suppression shall have an insulating barrier between the grounding screw and the mounting strap and triangle marking on the face to indicate isolated grounding type. The receptacles shall be NEMA 5-20R duplex, Hubbell #IG-5362 series, or approved equal by Bryant or ArrowHart. Receptacles shall be “orange” in color.
- e. Tamper-resistant, child-proof receptacles shall be equipped with a shutter mechanism that opens easily for insertion of 2 or 3-prong plugs, but prevents penetration of small objects into either slot. All such receptacles shall be hospital-grade, NEMA 5-15R duplex, Leviton #5262-SGW or approved equal.
- f. Clock hanger receptacles shall have a stainless steel plate and heavy duty 15 amp, 125 volt, grounding type receptacle, NEMA 5-15R, and shall be Hubbell Inc. HBL5236, P&S S3733-SS or approved equal by Bryant or ArrowHart.
- g. Weatherproof switches shall be 20 amp, 120 or 277 volts, tap action with waterproof neoprene plate, specification grade, self-grounding, Arrow Hart #2991 with #2881 plate or approved equal by Bryant or Hubbell.
- h. Break glass emergency shutdown switches shall be single-pole, double throw, flush or surface mounted, 5 amps at 250 volts, 10 amps at 125 volts, aluminum drip-proof construction, furnish and install as follows:
  - 1) Chiller (2) shutdown- ASCO #124202 (flush) or #124302 (surface) or approved equal by Bryant or ArrowHart.
  - 2) Boiler (2) and water heater (2) shutdown- ASCO #124201 (flush) or #124301 (surface) or approved equal by Bryant or ArrowHart.
  - 3) Coordinate control wiring of break glass switches and the associated equipment with Division 15 work.
- i. Push button emergency power off (EPO) switches shall be 2.375 inch mushroom head, non-illuminated, momentary push contact, labeled "Emergency Stop" in red, GE #CR104P Series or approved equal.



- j. Door switches shall be push button type, 6 amps at 125 volts, flush mounted in hinged side of door where indicated on plans, switch closed when door open, Arrow Hart #4029, P&S #1200 or approved equal by Bryant or ArrowHart.
- k. Lighted handle switches shall be illuminated when load is off, clear toggle, single or double poles or three-way, as indicated on plans, Hubbell #1221 and 1223 series, and 20AC3-CPL series or approved equal by Bryant or ArrowHart.
- l. Dressing room switched-receptacle remote pilot lights shall be wired to interior room switch for light "on" when load is "on". Lights shall be red round Lexan, 125 volts, to fit in a single receptacle plate, and shall be engraved "dressing room counter receptacles". Gang lights together for rooms with multiple switches/lights. Arrow Hart #87-Red.
- m. Wallbox dimmers
  - 1) Provide wallbox dimmers rated for loads and voltages to be controlled. Do not gang-mount (mount side-by-side) dimmers in same box or remove side sections so that dimmers may be used up to full rating. Provide separate wall boxes unless otherwise specifically noted on plans.
  - 2) Dimmers shall be "3-way" capable, using "smart remotes" which allow dimming control from each switch location.
  - 3) Provide 1000-watt-rated Lutron Maestro series dimmers where used in the vicinity of Decora-style wiring devices and switches. Provide 1000-watt-rated Lutron Faedra series dimmers where used in the vicinity of "standard" wiring devices and switches.
  - 4) Provide Lutron remote Power Boosters and Hi-Power 2•4•6 Dimming Modules as required to increase wattage capacity of specified wallbox dimmers and to provide compatibility between specified dimmer style and loads to be controlled. Power boosters and Hi-Power 2•4•6 Dimming Modules shall be suitable for incandescent, fluorescent, magnetic low voltage, electronic low voltage or neon/cold cathode lamp sources. Provide sizes as indicated on the drawings, or as required to control loads indicated.
  - 5) Provide dimming ballasts as required per Section 265000.
- n. Occupancy/Vacancy Sensors
  - 1) Sensors shall be automatic on (occupancy) or manual on (vacancy) as indicated on the drawings. Sensor operation shall incorporate dual technology digital passive infrared (PIR) detection to detect occupant motion and microphonic to detect occupant sound. Provide integral photocell to prevent lights from turning on if adequate daylight is available. Include a minimum on timer set at 15 minutes to preserve lamp life by eliminating short lamp cycles and a timer adjustable between 30 seconds and 20 minutes, and set at 10 minutes, to turn off if no occupancy is detected.

- 2) Ceiling mounted occupancy or vacancy sensor switches for single or multiple sensor operation with separately mounted auxiliary power and control unit. Sensor receives control power from the auxiliary power and control unit, and operates power switching contacts in that unit. Provide Sensor Switch CM-PDT 10 ceiling sensor with PP-20 series auxiliary power and control unit for each switched circuit and sPOD/sPOD-2P series low voltage wall switch for Manual On operation, or Wattstopper DT-300 with BZ-Series power pack and DCC2 low voltage momentary wall switch with green LED for Manual On operation, or Cooper Greengate OMC-DT with switch pack and Model AML wall switch for Manual On operation. Provide additional relay/power packs as required for larger loads controlled by single sensor switches. Provide auxiliary power packs for HVAC control where indicated on the drawings.
  - 3) Wall mounted occupancy or vacancy sensor switches for control of single circuit lighting loads shall be intelligent self-adjusting multi-technology types with integral manual “on” and “off” switch. Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts rated 800 W at 120-V ac, and 1000 W at 277-V ac, minimum. Provide Sensor Switch WSD-PDT VA rated 120/277 volts, 800/1200 watts, Wattstopper DW-100, or Cooper Greengate ONW-D-1001-DMV NeoSwitch, or Hubbell AD1277.
  - 4) Wall mounted occupancy or vacancy sensor switches for control of two circuit lighting loads (inboard/outboard lamp switching) or light and small fan loads shall be two pole intelligent self-adjusting types with integral manual override OFF switch. Provide Sensor Switch WSD-2P (first pole auto on/second pole manual on) rated 120/277 volts, 800/1200 watts, Wattstopper DW-200, or Hubbell AD1277x2.
  - o. Outdoor Pin and Sleeve Connections shall be 100 amp, 120volts, 3-phase, 4-pole, 5-wire, NEMA 4X, including neutral block and ground block with integral unfused disconnect switch mechanically interlocked to defeat tampering and to prevent the plug from being connected or disconnected while the receptacle is energized. Provide Hubbell Circuit-Lock series #HBL5100MI9W switch/receptacle and #HBL5100P9W plug or approved equivalent.
11. Telecommunications Faceplates Refer to IT Consultant’s Documents.
  12. Cable Television Outlets – Refer to IT Consultant’s Documents.
  13. Cover Plates
    - a. Provide compatible wall plate for each outlet and switch installed. Plates shall be .040" Type 302/304 stainless steel with brushed finish Submit sample to Architect and obtain acceptance prior to installation.
    - b. Replace existing wall plates in renovated areas to match new device wall plates. Provide Blank plates where required.

- c. Where two or more switches or devices are indicated at one location, mount under common plate.
  - d. Exterior cover plates shall be gasketed heavy duty die-cast zinc, with spring loaded, self-closing gasketed lift cover which maintains weatherproof integrity while in use.
  - e. Screws shall be metallic, with countersunk heads, finish same as plate, tamperproof where indicated.
  - f. Telecommunication outlets shall have cover plates to match area wiring device type and accommodate port configuration in each wall or floor box. Refer to other Sections for exact types.
14. See other Division 26 sections for wallbox dimmers, low voltage switches, and other special-purpose devices.

#### 2.08 GROUNDING MATERIALS

- 1. Provide a complete continuous grounding system to effectively ground the non-current carrying metal parts of every piece of installed equipment, and to provide a low impedance fault return to source.
- 2. Grounding materials shall be copper, bronze and/or brass construction with stainless steel or bronze threaded materials, listed and approved for the use. Cadmium or zinc-plated threaded materials are not acceptable.
- 3. Insulated grounding conductors shall be copper with green colored insulation, or black insulation totally covered with green vinyl tape at all taps and terminations, as permitted by NEC.
- 4. Conductors to be direct-buried shall be bare, tinned, stranded copper.
- 5. Connectors, clamps, straps, terminals, etc. shall be as manufactured by Burndy, Dossert, IlSCO or approved equal.
- 6. Ground rods shall be solid steel core with welded copper cladding (Copperweld or equivalent), 3/4" diameter x 10' long.
- 7. Provide factory kits for field-welded connections, Erico Cadweld, Thermoweld or approved equal.
- 8. Ground bus or grounding bars shall be bare annealed copper of rectangular cross-section, 2" wide x 1/4" thick unless otherwise indicated, complete with appropriate mounting hardware, clamps, and connectors. Hardware used with copper bar shall be silicon bronze.
- 9. Ground bars for the main telecommunications closet and satellite telecommunications closet grounding shall be tinned copper, with 304 stainless steel mounting brackets and pre-drilled holes, as specified in ANSI J-STD-607-A. Manufacturer: Erico Eritech series or approved equal.

- a. Telecommunications main grounding busbar (TMGB) shall be 4" high x 1/4" deep x 24" long. One TMGB shall be installed in the main telecommunications closet, or room.
- b. Telecommunications grounding busbars (TGB's) shall be 2" high x 1/4" deep x 18" long. TGB's shall be installed in each satellite telecommunications closet.

## 2.09 DISCONNECT SWITCHES

1. Provide safety switches where shown and required to comply with requirements of codes and enforcing agencies. Refer to Divisions 14 and 15 for additional information and requirements. See other Division 26 sections for panelboard and switchboard applications.
2. Disconnect switches indicated by symbol of box with slash on drawings, for two and three-pole loads greater than 1/2 horsepower, shall be heavy duty NEMA Type HD with quick-make/quick-break blades, rejection fuse holders, and equipment grounding kit; enclosures shall be NEMA Type 1 (interior dry locations), Type 4 (exterior or wet locations) and as shown on drawings. Switches rated 1200 amperes and larger shall be bolted-pressure or high-pressure-contact type as shown on drawings, 100% rated, per UL 977. Disconnect switches shall have a listed interrupting capacity of no less than the interrupting capacity of the installed fuses, where applicable, and minimum of 100,000 amperes, unless otherwise noted.
  - a. Enclosures shall have hinged door with interlock to prevent unauthorized door opening when switch is in "on" position, or closing of switch with door open.
  - b. Ampere ratings, voltage ratings, fusing and poles shall be as indicated or required. Provide non-fused type unless otherwise noted.
  - c. Provision shall be made for padlocking in "off" position.
  - d. Where fusing is indicated, and unless otherwise specified, provide as follows:
    - 1) Main service and feeder switches 0 - 600 amperes: Class RK1; specification grade, Bussmann Low-Peak, dual element, time-delay, 200 kA, Type LPN-RK (250 volt) or LPS-RK (600 volt) or approved equal by Gould-Shawmut.
    - 2) Main service and feeder switches 601 - 6000 amperes: Class L; Bussmann Low-Peak, Type KRP-CSP, 600 volt, time-delay, 300 kA, or approved equal by Gould - Shawmut.
    - 3) Motor and transformer branch circuits 0 - 600 amperes: Class RK5; Bussmann Fusetron, Type FRN-R (250 volt) or FRS-R (600 volt), time delay, 200 kA, or approved equal by Gould-Shawmut.
    - 4) Motor and transformer branch circuits 601 - 6000 amperes: Class L; Bussmann Low-Peak, Type KRP-C, 600 volt, time delay, 200 kA, or approved equal by Gould-Shawmut.

- 5) Non-motor branch circuits 0 - 600 amperes: Class J; Bussmann Low-Peak Type LPJ, 600 volt, dual element, time-delay, 200 kA, or approved equal by Gould-Shawmut.
  - e. Medium voltage fuses for transformer & feeder protection 1/2 – 750 amperes: E-Rated, current limiting, blown fuse indication, plated ferrules, 15.5 kV, 40 kA; Bussmann JC Series or approved equal by Gould-Shawmut.
  - f. Fuses shall be of the same manufacturer.
  - g. Provide three (3) spare fuses of each type and size installed, in manufacturer's original packaging.
10. Disconnect switches indicated by symbol  $S_M$  on drawings, for single-phase, one or two-pole loads, 1/2 horsepower and less, shall be toggle-type, AC manual motor starting switches with thermal overload protection to match the motor served. Switches shall be U.L. 508 Listed.
- a. Single-pole switches shall be rated 30 amperes at 120-240 VAC, 2 HP at 120 volts, 3 HP at 240 volts, with standard toggle with brown handle. Provide key-type or pilot light types where specifically indicated. Mount with appropriate backbox and coverplate per Section 2.02; NEMA 1 where indoors; NEMA 4 where outdoors. Square D Type FO1 or approved equal.
  - b. Two-pole switches shall be rated 30 amperes at 240 VAC (3 HP at 120 volts, 7.5 HP at 240 volts). Provide manufacturer's standard NEMA 1 enclosure where indoors; NEMA 4 enclosure where outdoors enclosure for each unless otherwise noted. Square D Type FO2 or approved equal.
11. Disconnect switches for elevators shall include integral shunt-trip mechanisms and auxiliary contacts for connection to fire alarm system.
- a. Switches shall be rated 600VAC and 200,000 amps RMS interrupting, for use with Class J fuses. Switches shall have integral 120 volt control power transformer, control power fuses and blocks.
  - b. Bussmann model #PS(1=100amp; 2=200amp; 3=30amp; 4=400amp; 6=60amp) with fire safety interface relay, control power transformer, isolation relay, key-to-test switch, pilot lights, NC auxiliary switch contacts, and fire alarm voltage monitoring relay, in NEMA 1 enclosure.
  - c. Mount switch in elevator machine room, within line-of-sight of elevator controller.
12. Provide accessory dry contacts in disconnect switches:
- a. For elevator equipment interlocks, battery emergency lowering, and as required by elevator equipment installer, in addition to requirements of paragraph F above.

- b. For motors controlled by an electronic variable frequency drive unit. Provide interlock wiring from auxiliary contacts to drive "Run-Permit" circuit to prevent drive from attempting to start motor with remote disconnect open.
- 13. Mount disconnect switches 4'-6" above finished floor to center of operating handle.
- 14. Fire alarm control panel disconnect switches shall be lockable in the on and off positions with red identification.

#### 2.10 ENCLOSED CIRCUIT BREAKERS

- 1. Where protective devices are indicated to be circuit breakers, provide manually-operated stationary mounting, U.L. listed types as follows:
  - a. Molded case circuit breakers up to and including 1200 ampere frame size unless otherwise noted.
  - b. Include adjustable magnetic trip from 100 ampere frame size up to 400 ampere frame size unless otherwise noted.
  - c. Breakers 400 ampere frame size and larger shall incorporate electronic trip units with field-interchangeable rating plugs within frame size. For emergency and standby distribution, provide electronic trip units as necessary to achieve selective coordination in accordance with the equipment manufacturer's short circuit study and NEC Articles 700 and 701.
  - d. Provide insulated case, fixed mounting circuit breakers above 1200 ampere frame size unless otherwise indicated.
  - e. See other Division 26 sections for panelboard and switchboard applications.
- 2. Electronic trip units shall include and display the following protective functions and features:
  - a. Adjustable long-time pickup and delay.
  - b. Adjustable short-time pickup and delay.
  - c. Adjustable instantaneous pickup (up to 10X).
  - d. Trip target for each function.
  - e. Voltage on each phase.
  - f. Instantaneous current on each phase.
  - g. Kilowatt hours & kilowatt demand.
  - h. Instantaneous kVA & kVA demand.
  - i. Power factor.
  - j. Harmonic distortion.
  - k. Phase failure.
  - l. Shunt trip where indicated.
  - m. Adjustable ground-fault pickup and delay (up to 1200 amperes pickup & 1 sec delay maximum) where indicated.
  - n. Arc-fault where indicated.
  - o. Cause of trip indicator target.

3. Provide 100% rated circuit breakers where indicated for application at 100% of the breaker's continuous current rating and UL 489 compliant. Circuit breaker shall be marked: 'Suitable for continuous operation at 100 percent of rating'.
4. Provide circuit breakers with handle locking devices and padlocking hasps where indicated.
5. Provide 100% rated circuit breakers where indicated for application at 100% of the breaker's continuous current rating and UL 489 compliant. Circuit breaker shall be marked: 'Suitable for continuous operation at 100 percent of rating'.
6. Enclosures: NEMA AB 1, Type 1 unless otherwise indicated or required to meet environmental conditions of installed location and as follows:
  - a. Outdoor Locations: Type 3R.
  - b. Kitchen Areas: Type 4X, stainless steel.
  - c. Other Wet or Damp Indoor Locations: Type 4.
  - d. Hazardous Areas Indicated on Drawings: Type 7C.
7. Provide equipment by the same manufacturer as the service equipment.

#### 2.11 SPD – SURGE PROTECTION DEVICES

1. Provide surge suppression devices where indicated on the drawings. Equipment shall be manufactured by a single manufacturer and listed to the following standards:
  - a. UL 1449, 3rd Edition updates effective September 29, 2009 "Surge Protective Devices".
  - b. UL 1283 "Electromagnetic Interference Filters".
  - c. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
  - d. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
  - e. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
  - f. National Electrical Code: Article 285.
  - g. SPD shall be UL labeled with 20kA nominal rating (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
2. SPD manufacturer shall have at least five (5) years experience in manufacturing surge protection devices and shall be ISO 9001 or 9002 certified.
3. Surge protection devices shall be connected on the load side of utility metering compartment and shall comply with local utility requirements.
4. SPD shall provide Standard 7 Mode Protection paths for modes of protection as follows:
  - a. Wye systems: Normal mode suppression line-to-line, line-to-neutral, common mode suppression line-to-ground and neutral-to-ground.

- b. Delta and impedance grounded wye systems: Line-to-line and line-to-ground.
5. Submittals shall include information describing each unit and as a minimum establish compliance with the following criteria:
- a. UL listed and labeled as Type 1 intended for Type 1 or Type 2 applications as follows:
- 1) Service entrance: 300 kA per phase and 200 kA short circuit current rating (SCCR).
  - 2) Distribution: 100 kA per phase and 200 kA short circuit current rating (SCCR).
  - 3) Branch: 100 kA per phase and 65 kA short circuit current rating (SCCR).
- b. Voltage Protection Ratings shall not exceed the following:
- | <u>VOLTAGE</u> | <u>L-N</u> | <u>L-G</u> | <u>N-G</u> | <u>L-L</u> | <u>MCOV</u> |
|----------------|------------|------------|------------|------------|-------------|
| 208Y/120       | 800V       | 800V       | 800V       | 1200V      | 150V        |
| 480Y/277       | 1200V      | 1200V      | 1200V      | 2000V      | 320V        |
- c. Maximum Continuous Operating Voltage (MCOV):
- | <u>System Voltage</u> | <u>Allowable System Voltage Fluctuation (%)</u> | <u>MCOV</u> |
|-----------------------|---|-------------|
| 208Y/120              | 25%   | 150V        |
| 480Y/277              | 15%   | 320V        |
- d. Suppression components shall be heavy duty metal oxide varistors and shall be field replaceable module(s) (service entrance only).
- e. Audible noise: 35db or less @ 3 feet from unit.
- f. Response time less than or equal to ½ nanosecond.
- g. UL 1283 listed EMI/RFI filter with noise attenuation: -50dB or greater at 100 kHz.
- h. Fusing: 200 kA symmetrical fault current interrupting capacity @ 600V.
- i. Phase and operational status indicator LED indicator lights for power and protection status.
- j. Surge counter (service entrance only).
- k. NEMA 1 enclosure with safety interlocked entry door.
- l. Integral circuit breaker or fused disconnect switch (service entrance only).
- m. Dual set of Form C dry contacts for remote monitoring.
- n. Audible alarm & alarm disable.
6. Approved manufacturers: Current Technology, Liebert, Siemens Industry, Inc. or Advanced Protection Technologies.

**2.12 CABLE SUPPORTS & CONDUIT VENTILATORS**

1. Provide cable supports for supporting electrical cables in vertical conduit risers per NEC Article 300-19.
2. Cable supports shall be clamping device type with ventilating capability suitable for non-armored cables, 600 volts or less, O.Z. Gedney Type S or approved equal.



3. Provide conduit ventilators to allow movement of air through the vertical conduit riser where shown on the drawings; O.Z. Gedney Type KVM or KVF or approved equal.

#### 2.13 CONDUIT AND CABLE SEALING BUSHINGS

1. Conduit sealing bushings for sealing conduit penetrations against fluid and air pressure shall be as follows as manufactured by O.Z. Gedney, Thunderline Corporation, Burndy or Thomas & Betts.
  - a. For walls which have or will have membrane waterproofing:
    - 1) Cast-In-Place Installations: OZ/Gedney Co.'s Type FSK thru wall seal and Type FSKA membrane clamp adapter.
    - 2) Core drilled or Sleeved Installations: OZ/Gedney Co.'s type CSM and type CSMC with membrane clamp adapter.
  - b. For walls which will not have membrane waterproofing:
    - 1) Cast-In-Place Installations: OZ/Gedney Co.'s Type FSK.
    - 2) Core Drilled or Sleeved Installations: OZ/Gedney Co.'s Type CSM or Thunderline Corporation Link-Seal CS-316.
  - c. Provide abandonment plates for unused openings.
2. Cable sealing bushings for sealing power cables in conduit shall be Type CSB, by O.Z. Gedney, Burndy or Thomas & Betts.
3. Cable seals for low voltage and signal cables shall be reusable simplex, duplex or triplex split design as required by Tyco Electronics or approved equal. Empty/spare conduit closed end caps shall be low temperature shrink Type LTCP by Tyco Electronics Raychem or approved equal.

#### 2.14 UNDERGROUND LINE IDENTIFICATION MARKER TAPE

1. Underground line identification marker tape shall consist of a reinforced protective plastic jacket bonded to an electronically detectable solid aluminum foil core constructed in a tape type format.
2. The product shall be resistant to acids and alkalis commonly found in soil.
3. The tape shall be minimum 6" wide.
4. The tape shall be installed 12" below finished grade, directly above the buried raceway or cables.
5. The following stock imprinting shall be provided:
  - a. "CAUTION Telephone Buried Below!", for telecommunications duct banks, direct burial cable and/or conduits. Use black letters on orange background.
  - b. "CAUTION Electric Line Buried Below!", for electrical duct banks, direct burial cable and/or conduits. Use black letters on red background.

6. Provide custom imprinting where indicated, or where necessary to suit special applications.
7. Provide products manufactured by Reef Industries, Inc., Terra Tape Sentry Line 1350 or approved equal Global Industries or CTGY.

2.15 TENANT SUBMETERING

1. Provide UL listed kWh/Demand tenant submetering equipment where indicated on the drawings. Metering shall be 1% accurate, fully electronic with LCD display for kilowatt hour and demand readings and mounted in a lockable NEMA 1 enclosure. Voltage and split core type current sensing shall be capable of remote mounting up to 2000 feet from meter and suitable for installation in panelboards, switchboards or separate enclosures as indicated without interrupting tenant circuit continuity. Each meter shall be capable of reading up to (3) sets of current sensors for cumulative (totalizing) readings. Submetering equipment shall be E-MON Corporation or approved equal.

2.16 SECURITY SYSTEM – Refer to Security Consultant’s Documents.

2.17 TELECOMMUNICATION SYSTEM Refer to Consultant’s Documents.

2.18 CABLE TELEVISION (CATV) SYSTEM – Refer to IT Consultant’s Documents.

2.19 CABLE TELEVISION (CATV)/SATELLITE DISH SYSTEM - Refer to IT Consultant’s Documents

2.20 POINT OF SALE (POS) SYSTEM

1. Electrical contractor shall furnish and install dedicated empty raceway and cable pathway system for the Point of Sale (POS) System. Equipment and cable installation are provided by the Owner’s POS System vendor.

2.21 PERSONAL COMPUTER NETWORKS

1. Electrical contractor shall furnish and install dedicated empty raceway and cable pathway system for the Personal Computer Network System. Equipment and cable installation are provided by the Owner’s Computer System Vendor.

2.22 ACCESS INTERCOM & DOOR RELEASE

1. Provide two-way open voice, hands free door answering system where indicated on drawings. Components shall include: door station, master station, power supply and wiring. A call from the weather resistant, door station sounds a momentary electronic tone at the indoor master station. To answer, press the “TALK” button to speak to the person outside the door, and release to listen. The person at the door speaks hands free. Master station includes capability for desk or wall mounting, individual voice volume and incoming call tone volume controls, and door release. A door release mechanism furnished with architectural hardware can be activated by pressing the door release button (key symbol). Door station shall be flush mount with stainless steel cover: Aiphone Model LE-DA. Master station shall be: Aiphone Model LEM-1DLS. Power supply shall be Aiphone Model 1PT-1210N plug-in transformer, 120/12 VAC.

2. Provide a vandal resistant intercom system including, but not limited to, Lobby Panel, Apartment Stations, Universal Audio Amplifier, transformers, wiring, and other equipment necessary to provide a complete operating intercom and door release system. The system shall be equipped for the quantity of apartments and stations as indicated on the drawings. Equipment supplied by Housing Devices, Inc. Series ACS or approved equal by Aiphone or Auth.
3. System Operation – A caller may press any push button on the front entrance Lobby Panel. This shall sound a signal at the Apartment Station being called. The tenant may converse by alternately pressing the Talk and Listen push buttons on the Apartment Station. If satisfied with the caller's identity, the tenant may press the button marked Door, which shall electrically operate the front entrance door opener permitting the caller to enter the building.
4. Lobby Panel shall be flush with tamper proof hardware and of all metal 16 gauge minimum stainless steel solid brass construction and contain one 7/16" diameter minimum flat metal button per apartment unit to initiate a two-way voice communication request for access to each specific apartment in the building. Provide panel capacity for the specified number of apartment units. Apartment numbers shall be engraved on the lobby panel and be 5/32" in height or larger. Braille characters shall be stamped beside each apartment unit's button. Braille strips are not acceptable. Provide electronic Postal Release key switch with two (2) keys. Minimum 3" diameter panel speaker shall be of Mylar construction not paper cone construction. Include a set of normally open dry contacts for connection to a remote audio-visual station or CCTV cameras or a DTMF phone dialer.
5. Apartment Stations shall be of all metal 20 gauge minimum stainless steel construction. Buttons shall be activated with a minimum of effort and be "slam resistant". Buttons shall be silkscreen labeled "TALK", "LISTEN", "DOOR". Provide dry contacts for connection of strobe light, remote audio visual annunciator, or DTMF dialer.
6. Audio Amplifier shall be Housing Devices ACS-35 or approved equal and shall contain the control, amplification, and power circuits to operate the system. The amplifier shall contain delay door opener adapter for postal door release, separate volume controls for both apartment stations and lobby panel.
7. Transformer & wiring shall consist of a minimum 16 volt 30 VA dry transformer mounted in a standard outlet box and minimum #22 AWG twisted pair copper wire for interconnections.
8. Installation shall be according to manufacturer's recommendations and ADA. Shop drawings shall include field wiring diagrams, operating instructions, parts list with numbers and name, address and telephone number of parts source. Test each station for proper operation.

## 2.23 BATHROOM EMERGENCY CALL SYSTEM

1. Provide complete bathroom call system in handicap accessible bathrooms as shown on the drawings and as required by code.

2. The complete 110 Volt A.C. system kit #HV110 shall be manufactured by Auth, Florence or approved equal by MDI and include the following components:
  - a. Pull cord shall be #206-2 single gang, 2 pole mechanically locking switch, 6 foot long pull cord with pendant and provide pull string and insulating bushings at ends .
  - b. Corridor station shall be #302-2C, 110 volt, single dome light and buzzer.

#### 2.24 AREA OF REFUGE EMERGENCY CALL SYSTEM

1. Provide remote area of refuge communication devices and master controls with UL listed battery backup, supervised circuits and complete with accessories located as shown on drawings as manufactured by Housing Devices, Inc. ADA 100 Emergency Call System, Medford, MA (T: 800-392-5200) or approved equal by Auth or Cornell.
2. Remote area stations shall be two-way communication with the master station, hands-free operation, flush mounted with stainless steel vandal resistant intercoms, 90 dBA piezoelectric alarms, 3-inch panic buttons labeled "PUSH FOR HELP", momentary keyed reset switch, dry contacts for connection to strobe light, video camera, DTMF dialer, red LED indicators for "HELP REQUESTED" and "HELP COMING", and adjacent raised letter Braille instructional signs reading "For Assistance Push 3-inch Help Button". Back box size: 7-5/8"x7-5/8"x3-1/2". Provide surface mount collar for existing wall installation. Provide stainless steel weather hood for outdoor installations. Provide illuminated Area of Rescue sign by Housing Devices, Inc. ADA (Area of Rescue Illuminated Signs).
3. Master station unit shall include controls for remote area stations, system reset key switch and shall accommodate up to 60 remote area stations. Master station(s) shall have the capability of communicating with remotes, both individually and all at once. Provide quantity as required to monitor remotes indicated on drawings. Master station back box size: 7-5/8"x7-5/8"x3-1/2" (1-5 areas) or 13-1/2"x7-7/8"x3-1/2" (6-10 areas).
4. Each relay card cabinet with control board holds up to 10 electronics support relay cards, one for each remote area station. Provide one relay card for each remote. Relay card cabinet size: 12"x12"x4".
5. Amplifier & battery cabinet processes the audio for the entire system and monitors for AC power failure, AC and DC surge suppression and no/low battery indications and flush mounts adjacent to the master station. Amplifier & battery cabinet size: 12"x12"x4". Provide surface mount collar for existing wall installation.
6. Provide interconnected cable and conductors as recommended by the manufacturer, installed in conduit and as follows:
  - a. Area station and master station wiring shall be four (4) #18 AWG shielded twisted pairs; Belden 9554, West Penn 3753 or approved equal. Additionally, provide three (3) #18 AWG conductors (shield not required) for each area station.
  - b. Fire Alarm Control Panel: Two (2) #14 AWG.

7. Provide interlock with main fire alarm control panel as common trouble signal for electrical failures including shorts, opens and power outages. To prevent tampering under normal conditions, provide a relay system to disconnect both AC and DC power to the Call System. Restore power to the Call System upon signal from the fire alarm control panel or the emergency generator control panel.

#### 2.25 ELECTRIC CORD & CABLE REELS

1. Provide cord and cable reels suitable for mounting on ceiling, wall, floor or bench as INDICATED on drawings. Reels shall be steel construction with powder coat finish, multi-position nylon roller guide arm, positive-latch mechanism and including 45 feet of #12 AWG Type SJEO yellow jacketed three-conductor cord including insulated ground. Include quad NEMA 5-20R GFI outlet box and Kellems strain relief. Hubbell Industrial Cord Reel HBL45123R series or approved equal by Appleton or Desisti.

#### 2.26 ELECTRIC RADIATION HEAT

1. Heaters shall be low profile (3 x 5-3/4"; 5" x 7-1/4") and available in lengths from 28 inches through 10 feet.
2. Enclosures shall be 16 gauge furniture quality steel or 14 gauge aluminum with reinforced, all welded, construction; designed to withstand heavy-duty commercial and institutional use.
3. Pedestal legs shall be architecturally styled, made of extruded aluminum, and available in four anodized finishes. Legs shall be individually adjustable to insure an even level heater installation.
4. Enclosures shall be chemically-treated to resist corrosion. Finish shall be mar and temperature resistant to retain contemporary appearance throughout years of rough use.
5. Heating elements shall be constructed of aluminum to achieve lower operating temperatures and more efficient heat transfer. One, two, or three, low density elements shall be installed side-by-side on the same plane to uniformly warm all incoming air. Elements shall be center-anchored and shall float freely on each end through nylon bushing for quietness.
6. Top discharge grille shall be extruded aluminum, available in four anodized finishes. Heaters shall be designed so that front covers can be easily removed for individual servicing in a wall-to-wall run.
7. A 1/4 inch mesh screen shall be installed beneath the discharge grille to deter the insertion of foreign objects.
8. Built -in controls shall include single-pole double-pole, or two-stage thermostats, disconnect switch, transformer relay and power relay. The thermostat shall be capable of controlling multiple units on a pilot duty circuit.
9. An automatic reset thermal overheat protector shall run the full-length of the heater and shall turn off heating elements should overheating occur at any point along heating length. Overheat protector shall restore operation automatically when cause of overheating is removed.

10. Heaters and blank sections shall be designed so they can be butted together with use of splice plates.
11. Heaters shall be designed with a built-in pre-wired raceway to enable multiple unit wiring from one feeder source.
12. Back panel shall be one-piece painted steel, completely finished, and shall be suitable for mounting in front of a glass curtain wall.
13. All heaters and electrical accessories shall be labeled by Underwriters Laboratories, Inc.
14. Accessories shall include end caps, blank sections, and splice plates.
15. Manufacturer: Qmark, Type QMKC, Berkman or approved equal.

#### 2.27 HEAT TRACING SYSTEM

1. Furnish and install a complete UL listed system of self-regulating heating cables and components listed specifically for heat tracing applications. Refer to plumbing and mechanical documents for locations. The control equipment shall provide the required GFI protection for the heat tracing system. The system shall be modular for ease of expansion and shall provide complete system status and parameters locally, and remote alarm to the BMS. Provide north and south roof/gutter zoned systems for varying snow melting and icing conditions due to shading or temperature variation.
2. Complete system including cable, components and controls shall be by same manufacturer. Heat tracing products to be manufactured by Raychem Corporation or pre approved equal by Thermon or Tycothermal.
3. The heating cables shall be self-regulating heaters with a power output of 12 watts/ft. at 208 VAC when exposed to ice or snow at 32°F and a power output of 5 watts/ft. at 32°F when dry.
4. The maximum self-generated temperature shall not exceed 136°F under any circumstances, as tested by UL.
5. The heating cable construction shall be as follows:
  - a. An outer jacket of U.V. stabilized fluoropolymer. (A PVC jacket shall not be acceptable.)
  - b. A tinned copper braid under the jacket. (A stainless steel braid shall not be acceptable.)
  - c. An inner jacket of modified polyolefin that is radiation crosslinked. (Heating cables with non-crosslinked jackets shall not be acceptable.)
  - d. A radiation crosslinked self-regulating heating core. (Non-crosslinked heating cores shall not be acceptable.)
  - e. Two 16 AWG nickel coated copper bus wires embedded in the conductive polymer heating core.

6. Standard pipe heating cable shall not be acceptable unless it has a UL listing specifically for roof and gutter de-icing applications.
7. The heating cable shall be UL listed.
8. The heating cable shall be IceStop GM-2XT Ice Stop self-regulating heating cable for operating voltages between 208 and 277 volts.
9. Power Connection, end seal, splice and tee kit components shall be applied in the field per manufacturer's instructions.
10. GFI protection shall be provided for all branch heater cable circuits. GFI shall have a 30 mA trip level.
11. The manufacturer shall be ISO 9001 certified.
12. The heating system (the heating cable and components for power connection, terminations, splices, and attachments to the roof) shall have a UL system listing specifically for use as a roof gutter de-icing system.
13. Digitrace 920 Control
  - a. Each heater cable shall be individually controlled by a line temperature sensing device. The GIT-3A shall be located in the gutter as indicated on the contract drawings. Failure of a temperature sensor shall be indicated at the system monitor panel. Mechanical thermostats shall not be used.
  - b. Each heater cable including all tees shall be monitored and provide alarms for high and low current and high and low ground fault.
  - c. The control system shall energize each heater cable independently when the pipe temperature drops to 40 degrees F. The system shall indicate an alarm condition when the pipe temperature drops to 35 degrees F.
  - d. Each monitor channel shall have a separate microprocessor and alarm group. Each monitor panel shall be NEMA 4X, and UL approved construction. The panel shall operate off of the heater cable power supply, at that voltage.
14. Each monitor channel shall have autocycling capability. All set points and diagnostics shall be stored in non-volatile memory. Alarms shall be provided for memory and SCR failures.
  - a. The system shall be Raychem Digi trace 920 system.
15. Provide 3/8-inch scale shop drawings indicating cable layout, installation details, with locations for junction boxes, controls, contactors and control wiring. Include design criteria and calculations based on local conditions and manufacturer's installation and operation instructions.

## 2.28 LOW VOLTAGE LIGHTING POWER SUPPLIES

1. Provide toroidal transformer low voltage power supplies designed with manual taps to achieve 12, 13, 14, and 15 volts for 12 volt operation and 24, 26, 28, and 30 volts for 24 volt operation as indicated on drawings. Proper transformer wattage shall equal or exceed total

lamping wattage without derating as indicated on drawings. 120 volt primary and 12 volt or 24 volt secondary voltage compartments shall be separate. Housing shall be suitable for recessed or surface mounting for both walls and ceilings with zero clearance to combustible materials with damp locations label. Power supply shall be inherently protected and include primary and secondary overcurrent circuit protection. Size power supply overcurrent protection according to manufacturer's recommendations.

2. Products shall be QT- or QX Series by Q-Tran, Inc., or approved by square D or Magnetek.

#### 2.29 EMERGENCY SHUNT RELAY DEVICES

1. Provide shunt relay devices to power egress lighting regardless of fixture switch position where indicated on the drawings. The device shall be capable of shunting around the local control including switch, dimmer, occupancy sensor or relay when normal utility power has been lost. An un-switched source of power on the same branch circuit as the AC ballast is required. The device shall not affect normal fixture operation when wired to a direct, un-switched connection to a generator-supplied or central inverter-supplied lighting circuit.
2. The shunt relay device shall be a normally-closed, electrically-held relay wired in parallel with wall switch as detailed on drawings. Operation shall be such that the manually controlled emergency lighting shall be automatically energized "on" during a power outage. Relay shall fit in a 4" x 4" x 2.125" junction box, maximum 1 watt power consumption, 120V or 277V coil rating as required, 20A contact rating up to 277V, UL 916 and UL924 compliant. Manufacturer: Lighting Controls & Design (LC&D) Emergency Shunt Relay, Bodine, Squared D or approved equal.
3. Refer to details on drawings for relay types and control configurations.

#### 2.30 VARIABLE VOLTAGE POWER SUPPLIES

1. Furnish and Install (5) Hampden Engineering Variable voltage (portable) power supplies Model #BPS-3618-P in the physics science room.

### PART 3 - EXECUTION

#### 3.01 WIRING & RACEWAY - GENERAL

1. The drawings show the general layout and typical details. Provide complete systems. Drawings are based on the specified equipment. Raceway layouts, boxes, and wiring of the systems are subject to approved shop drawings.
2. Ensure that items to be furnished fit the space available. Make necessary field measurements to ascertain space requirements, including those for connections, and provide such sizes and shapes of equipment that final installation shall satisfy the intent of the drawings and specifications.
3. Locations of outlets, switches, appliances, etc. as shown on Electrical plans are approximate; coordinate with Architectural and Mechanical plans and details, and with job conditions. Install switches with "OFF" position down and on the strike side of doors, unless otherwise



noted. Install receptacles with grounding pole in the up position for vertical mounting and at left for horizontal mounting.

4. Locate and install electrical equipment, junction and pull boxes, panelboards, switches, controls, and other apparatus requiring maintenance, inspection, and operation so as to be readily accessible. For finished locations, provide a suitable marked, hinged access panel only where approved by the architect.

### 3.02 RACEWAY INSTALLATION

1. Install conduit in accordance with the NECA "Standard of Installation".
  - a. In architecturally finished spaces, conduits and cables shall be run concealed in hung or furred ceilings, slabs, masonry, and partitions unless otherwise indicated. In unfinished spaces, raceways may be run exposed.
  - b. Raceway installation at existing slabs, existing masonry walls and existing furred partitions in finished areas shall be as indicated in the raceway schedule listed in paragraph 2.01, saw-cut or chopped into existing floor or partition and patched, unless otherwise specifically noted. Surface raceways shall only be used where specifically indicated or permitted by the Architect.
  - c. Submit shop drawings for exposed conduits or raceways indicated on drawings in architecturally finished spaces.
  - d. Shop drawings shall demonstrate coordination with related trades and the ability to provide a neat and workmanlike installation.
2. Unless otherwise indicated, exact routing of raceways shall be determined by the Contractor to suit project requirements and field conditions.
3. Where raceways cross expansion or seismic joints, provide approved expansion fittings, or combinations of fittings, which allow deflection in all directions equal to twice the movement allowed in the structural design. For conduits 1-1/4" trade size or smaller, a 24" length of flexible metal conduit, with bonding jumper, slack mounted, may be used.
4. Provide sealing bushings on the ends of underground conduits that terminate at indoor equipment, or interior conduits where subject to different temperatures or where condensation is known to be a problem as in cold storage areas. Install appropriate sealant after installation and testing of cables.
5. Raceways and cables shall be neatly arranged on hangers and supports, with fittings designed for the purpose, and shall be installed parallel and perpendicular to walls, floors, structure and ceilings in a neat and workmanlike manner. Group related raceways; provide space for 25 percent additional raceways.
6. Raceways installed in close proximity to pipes of other trades shall be arranged to allow proper clearance for servicing, headroom and the like. Maintain minimum 6 inch clearance from steam, hot water, and flue piping.

7. Conduit ends shall be reamed smooth and interiors shall be wiped clean and dry.
8. Use of running threads is not permitted; use conduit unions or split couplings in areas where threaded conduit cannot be turned.
9. Conduits passing through roof construction shall be flashed watertight.
10. Raceways shall be supported at intervals less than approved equal to code with seismic bracing as described in this section.
11. Locate pull boxes, junction boxes, pull fittings, etc. to comply with code and to prevent recommended values of wire and cable tensions and side wall pressures from being exceeded.
12. Conduit in concrete or masonry shall be securely held in place during pouring and construction operations. Where conduits are run underneath metal roof decking, provide spacers for 1-inch minimum gap between conduit and roof deck to avoid penetration of conduit by roofing fasteners. Change from non-metallic conduit to rigid steel conduit before rising above the floor.
13. Provide a suitable pullstring in each empty conduit except sleeves and nipples less than 24 inches.
14. Use suitable caps to protect empty conduit against entry of dirt and moisture.
15. Conduits and/or sleeves shall not be placed in concrete slabs or walls with prior approval of the Architect. Prepare a submittal detailing the number, size, spacing and layout of the proposed conduit and/or sleeves including material specifications. Adhere to the following limits in planning the conduit embedments:
  - a. Maximum outside diameter of embedded conduit or sleeve:  $\frac{1}{4}$  the thickness of the slab or wall.
  - b. Minimum center-to-center conduit spacing: Six (6) times the outside diameter of the conduit.
  - c. Conduits shall be firmly supported at the mid-thickness of the slab or wall and shall be wired into place.
  - d. Conduits shall not be placed in contact with the concrete reinforcement.
  - e. Use of aluminum conduit or sleeves for embedment in concrete is not permitted.
  - f. Conduit or sleeves shall not be placed in columns or beams.
16. Close ends of conduits immediately after being placed to keep out foreign matter. The entire conduit system shall be tested for obstructions, omissions and smooth joints by fishwire, and thoroughly swabbed out and made dry before pulling any wire.
17. Install covers on boxes and raceway fittings. Plug unused open knockouts and hubs.
18. Do not install outlet boxes back-to-back in walls. The use of thru-wall boxes is strictly prohibited.

19. Provide phenolic insulating connectors for metal conduits containing BOTH normal ground AND isolated-ground conductors, where the conduit is NOT being used as the equipment grounding conductor. (For conduits containing only a normal ground conductor or only an isolated ground conductor, where the conduit is also used as the equipment grounding conductor, provide galvanized couplings and connectors.)
20. Provide separate raceways, junction boxes, pull boxes and wireways for emergency system wiring.

3.03 WIRING INSTALLATION

1. Do not use wire smaller than No. 12 AWG for any power or lighting circuit. Use larger sizes where indicated, as required by codes, and as follows:
  - a.
 

30 ampere circuit:	No. 10
40 ampere circuit:	No. 8
50 ampere circuit:	No. 6
60 ampere circuit:	No. 6

- b. Minimum homerun and branch circuit wiring sizes and maximum homerun conduit fill for 120 Volt, 20 ampere circuits shall be as follows:

Length	Circuit Wire Size	Home Run Wire Size	Conduit Size (9 current-carrying conds.+ G)
0' to 50'	#12	#12	3/4"
51' to 100'	#12	#10	3/4"
101' to 200'	#10	#8	1" (1-1/4" for 9 #8 AWG +G)

Greater than 200' - Request Direction from Architect.

**Note: Provide derating per Code when installing more than 3 current-carrying conductors in conduit.**

- c. Home runs and branch circuit wiring for 277 Volt, 20 ampere circuits shall be as follows:

Length	Circuit Wire Size	Home Run Wire Size	Conduit Size (9 current-carrying conds.+ G)
0' to 100'	#12	#12	3/4"
101' to 200'	#10	#10	3/4"

Greater than 200' - Request Direction from Architect.

**Note: Provide derating per Code when installing more than 3 current carrying conductors in conduit.**

2. Do not use wire smaller than No. 14 AWG for control circuits unless otherwise recommended by the equipment or system manufacturer on wiring shop drawings, and so approved by the Architect.

3. Where greater than three (3) current-carrying conductors are installed in any one conduit or cable, conductors must be derated and sizes increased, if needed, to accommodate conductor derating as required by NEC Article 310.15(B)(2)(a) Allowable Ampacities of Insulated Conductors Rated 0-2000 volts. **Do not install more than nine (9) current-carrying conductors in conduit or raceway without approval from the Engineer.**
4. Where conductors in conduits supported above roofs are exposed to sunlight, apply ambient temperature ampacity adjustment factors per Table 310.15(B)(2)(c) according to distance above roof from bottom of conduit.
5. Make splices only at outlets or accessible junction boxes. Make splices No. 10 AWG and smaller with Buchanan B-Cap wire-nuts or equivalent insulated solderless twist-on connectors. Make joints, taps, and splices in wires No. 8 AWG and larger with solderless mechanical connectors enclosed in molded covers. Splices shall be UL listed for the environment.
6. When pulling conductors through conduits, care shall be taken not to exceed manufacturer's maximum tension and side wall pressures.
7. Wire shall not be installed until work which may cause injury to wiring has been completed, and conduits are cleaned and dry.
8. Conductors shall be completely installed and connected. Provide terminals, lugs, and connectors to suit the application, and in compliance with equipment manufacturers' recommendations.
9. Branch circuit wiring for lighting and other single phase applications shall be multi-wire, utilizing common neutrals, except dimmer circuits shall have separate neutrals, and as otherwise indicated.
  - a. Under no circumstances shall any switch or circuit breaker break a neutral conductor.
  - b. The circuit numbers indicated on the drawings are intended as a guide for proper connection of circuits at panels. However, it shall be the responsibility of the Contractor to ensure that the final circuiting work fulfills the following conditions:
    - 1) Loads on panel busses shall be phase-balanced as evenly as possible.
    - 2) No neutral conductor shall be common to more than one circuit conductor of the same phase leg.
  - c. Receptacle, fluorescent lighting, and electronic low voltage lighting (track or fixed) branch circuits shall be considered non-linear loads and shall be provided with either individual dedicated 100% neutral wires, or a common neutral wire sized at 173% ampacity of the phase wires.
  - d. Provide two-pole circuit breakers for multi-wire circuits that supply devices or equipment on the same yoke or strap.

10. Wire lubricant shall be used to ease the pulling of cables and conductors in conduits. The lubricant used shall be fully compatible with the wire insulation or cable jacket material.
11. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
  - a. Color-code 208Y/120-V system as follows:
    - 1) Phase A: Black.
    - 2) Phase B: Red.
    - 3) Phase C: Blue.
    - 4) Neutral: White.
    - 5) Ground: Green.
  - b. Color-code 480Y/277-V system as follows:
    - 1) Phase A: Brown.
    - 2) Phase B: Orange.
    - 3) Phase C: Yellow.
    - 4) Neutral: White with a colored stripe or gray.
    - 5) Ground: Green with a yellow stripe.

### 3.04 GROUNDING & BONDING INSTALLATION

1. Install a complete building, equipment, and system grounding and bonding network as indicated and specified, and to meet or exceed the requirements of NEC Article 250 and the local utility.
2. Grounding Electrode System
  - a. Install a buried and looped bare tinned copper #4/0 AWG grounding electrode conductor to (4) equally spaced ground rods located outside the building electrical service entrance, 18-24 inches below finished grade. Connect both ends of the looped bare tinned copper #4/0 AWG grounding electrode conductor to the service equipment ground bus.
  - b. Bond structural steel ,architectural metal building cladding and interior metal piping at accessible points to the grounding electrode system. Size bonding conductors per NEC. Interior metal piping to bond includes: water, fire protection, gas, waste, drain, vent, pneumatic, oxygen, air and vacuum systems.
  - c. Install a concrete-encased (Ufer) electrode located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth. Electrode shall consist of 25' minimum of bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods not less than 1/2" in diameter, or of 25' of #4/0 AWG bare copper conductor.
  - d. Install grounding electrode system at each remote building or structure supplied from the main building electric service where the remote building or structure is supplied by more than a single branch circuit – see NEC Article 250.32 (A).

- e. Where applicable, bond lightning protection grounds to the ground ring.
  - f. After completion of installation, test earth ground resistance by fall-of-potential or other approved method. If test result is greater than 3 ohms, drive two (2) additional ground rods and bond to system. Provide a certified report of the test methods and results, including any corrective actions taken. Do not use salt or other chemical means to reduce earth resistance, unless so directed by the Architect.
3. System Grounding
- a. Bond the service entrance grounded conductor to the looped bare tinned copper grounding grid. Size conductors per NEC, but use no smaller than No. 4 AWG.
  - b. Where applicable, bond the secondary neutral terminal ( $X_0$ ) and tank grounding pad of the outdoor transformer to the transformer grounding grid and to the service grounding point as shown on the drawings. Size conductors per NEC, but use no smaller than No. 4 AWG.
  - c. Generator systems with 4-pole transfer switches: Install a neutral bonding link between the neutral ( $X_0$ ) terminal and the equipment grounding terminal of the generator. Connect generator equipment grounding conductor to the building ground electrode for indoor installations. Additionally, for outdoor installations, provide a supplemental ground rod. Size conductors per NEC, but use no smaller than No. 4 AWG.
4. Equipment Grounding
- a. Install an insulated ground conductor, run in the raceway with the phase conductors, for each feeder serving: panelboards, lighting dimmer boards, motor control centers, motors, equipment and appliances unless otherwise noted.
  - b. Include an insulated ground conductor in conduit runs containing sections of flexible conduit unless otherwise noted.
  - c. Include an insulated ground conductor in branch circuit raceways or cables unless otherwise noted.
  - d. Provide bonding bushings and bonding conductors for boxes with concentric, eccentric or over-sized knockouts. The bonding conductor shall be sized per NEC Table 250-122 and lugged to the box.
  - e. Bond each separately derived system transformer. Bond grounded conductor ( $X_0$ ) to the transformer case, to the nearest available interior metal water piping, to nearest grounded building steel, and to other metal piping in accordance with requirements of NEC Article 250. Size conductors per NEC, but use no smaller than No. 4 AWG copper.

- f. Include a driven ground rod at each outdoor lighting standard (lighting pole mounted on concrete pedestal base). Provide #8AWG bare grounding electrode conductor from ground rod through sleeve in concrete pedestal to grounding bushings on metallic conduit stubs within light pole, and to pole grounding terminal. Grounding connections shall be accessible from pole handhole.
5. Computer Floor Grounding
- a. For each area of raised floor not interconnected by pedestal stringers, ground a pedestal from each corner to the single point ground bus for the area. Use No. 8 AWG bare copper.
6. Telecommunications Closet Grounding
- a. Provide a green insulated #4 AWG ground conductor riser in 1" EMT conduit to each telecommunications closet grounding busbar (TGB) from the telecommunications main grounding busbar (TMGB), and to main service grounding system.
  - b. Connect the ground riser to TMGB and TGB's per ANSI-J-STD-607-A.
  - c. Provide additional green insulated #4 AWG ground cable connections from each TMGB and TGB to the closest building steel and to the ground bus in the electric panel feeding the outlets and equipment in the associated telecommunications room/closet.
  - d. Ground each telecommunications, fire alarm, security, and BMS system equipment and control panel within each telecommunications room/closet to the associated closet TMGB or TGB with an green insulated #4 AWG conductor per ANSI J-STD-607 - A.
7. Specialty Grounding
- a. Provide ground connections for anti-static floor covering materials according to manufacturer's installation instructions.
  - b. Audio Isolated Ground Test - Verify the integrity of the audio isolated ground system, as follows:
    - 1) Confirm that continuity is measured between each isolated ground receptacle/outlet neutral conductor and the grounding electrode connection at the audio isolation transformer.
    - 2) Disconnect the neutral bonding link at each audio isolation transformer and confirm that the neutral buss is isolated from the building ground. Locate and remove connections between the neutral buss and the building ground other than the main bonding jumper. Reconnect the neutral bonding link.

- 3) Confirm that continuity is measured between each isolated ground receptacle/outlet ground conductor and the grounding electrode at the audio isolation transformer.
- 4) Disconnect the isolated ground bonding link at each audio isolation transformer and confirm that the isolated ground buss is isolated from the building ground. Locate and remove connections between the isolated ground buss and the building ground other than the main bonding jumper. Reconnect the isolated ground bonding link.
- 5) Confirm that each isolated ground receptacle/outlet is wired with correct polarity.

3.05 RACEWAYS FOR TELECOMMUNICATION SYSTEMS – Refer to IT Consultant documents.

3.06 RACEWAYS FOR CATV SYSTEM – Refer to IT Consultant documents.

3.07 RACEWAYS FOR SECURITY SYSTEM – Refer to Security Consultant documents.

3.08 RACEWAYS & CABLE PATHWAYS FOR POINT OF SALE (POS) SYSTEM

1. Provide empty conduit raceway and cable pathway systems as described here and shown on the drawings for POS work, complete with flexible non-compressing cable hangers, conduit, pull boxes, and outlet boxes, as indicated on the drawings and to Category 6 standards. Refer to raceways and cable pathways for Telecommunication System for additional requirements.

3.09 RACEWAYS & CABLE PATHWAYS FOR PERSONAL COMPUTER NETWORK

1. Provide empty conduit raceway and cable pathway systems as described here and shown on the drawings for Personal Computer Systems work, complete with non-compressing cable hangers, conduit, pull boxes, and outlet boxes, as indicated on the drawings and to Category 6 standards. Refer to raceways and cable pathways for Telecommunication System for additional requirements.

3.10 ELEVATOR EQUIPMENT WIRING

1. Work Included
  - a. Elevator equipment wiring includes power service connections, telephone service connections, public address system connections elevator management interaction and monitoring system and fire alarm system connections.
  - b. Elevator control wiring and interlock controls are not included.
2. Components
  - a. Provide distribution panelboard circuit breaker and elevator machine room shunt-trip fused disconnect with dry contacts for elevator drive unit power, and power wiring complete to the drive unit.



- b. Provide dedicated panelboard for elevator branch circuits including circuits for: elevator cab, machine room GFI convenience outlet, pit GFI outlet, machine room lights, pit lights, sump pump and emergency lowering; use emergency power where available.
- c. Provide conduit for elevator communication systems.
- d. Provide conduit and wire for elevator recall system; coordinate requirements with fire alarm system.
- e. Provide elevator pit and machine room lights, receptacles and switches.
- f. Provide dedicated circuit and connections for elevator pit sump pump.
- g. Provide conduit and wire as follows for the elevator recall system - coordinate requirements with fire alarm system and elevator contractor:
  - 1) Provide (1) set of normally open dry contacts, per elevator, subject to activation by the smoke detectors at the elevator lobbies, machine rooms, and hoistways. The contacts shall be wired to a junction box located inside each elevator machine room for connection to the elevator controls systems by the Elevator Contractor. Each wire shall be clearly labeled with its control function.
- h. Provide 135°F heat detectors at the top of the shaft, pit and machine room, and interlock with the drive unit power source to disconnect power at the local disconnect switch upon sensing of heat and before activation of any sprinkler heads. Provide voltage monitoring relay with (1) set of normally open and (1) set of normally closed dry contacts, per elevator, in each elevator power supply disconnect to monitor presence of voltage in the elevator power shunt trip switch and signal the fire alarm control panel upon loss of power. The contacts shall be wired to the fire alarm control panel. Each wire shall be clearly labeled with its control function.
- i. Provide (1) set of normally closed dry contacts, per elevator, subject to activation following transfer to the building emergency power supply; interface with ATS time delay/programmed transition option as specified in 263200. Also provide (1) set of normally closed dry contacts, per elevator, to signal the elevator remote control system the power source will transfer from emergency to normal source; interface with ATS time delay option as specified in 263200. Contacts shall be wired to a junction box located inside each elevator machine room for connection to the elevator control equipment by the Elevator Contractor.
- j. Provide locking mechanisms for overcurrent devices on branch circuits serving elevator equipment including cab, pit and machine room lighting, ventilation, receptacles and controller power.

- k. Provide empty conduit for elevator management interaction and monitoring system to include empty conduit from each elevator hoistway to the CRT display located in the remote Building Management/Building Engineer's Office as indicated on the drawings. Wire installation and termination are by the elevator contractor.
3. Coordination
- a. Coordinate entire installation with elevator system supplier prior to commencement of work.
  - b. If the horsepower rating of the equipment furnished by the elevator supplier differs from the horsepower listed on the contract documents, the contractor shall notify the Architect prior to installing any work and obtain direction.

### 3.11 OWNER SUPPLIED EQUIPMENT

- 1. The Division 26 Contractor shall be responsible for the connection of the owner-supplied equipment. The connection shall include parts, labor, cabling, boxes, conduit, circuit breakers, and wiring.
- 2. The Division 26 Contractor shall review the equipment schedule as indicated on the documents for equipment types, voltage, amperage, phases, and horse power. The contractor shall provide as required wiring and connections to match equipment types. The contractor shall carry combination fusible starter disconnects for equipment.
- 3. The Division 26 Contractors shall inspect the owner provided equipment as it is delivered to the project site, coordinate the locations of the equipment and voltage, amperage, phases, and horse power. The Division 26 Contractor shall locate the equipment, as they are shown/indicated on the contract documents. Refer to Architectural drawings for equipment locations and coordinate with the electrical drawings.
- 4. The Division 26 Contractor shall furnish and install required electrical components for a complete and functional equipment installation.

### 3.12 MECHANICAL EQUIPMENT WIRING

- 1. Unless otherwise indicated or specified herein, motors, motor starters, motor controllers, variable speed/frequency drives, and associated control devices are furnished by other Divisions and installed by this Division. Coordinate installation and locations with other Division contractors.
- 2. Power wiring from the indicated source to the starter/controller/drive unit, and from the starter/controller/drive unit to the motor, including any local disconnect switches provided and installed by this Division, and associated lugs, terminals, and connections, is the work of this Division.
- 3. Verify correct voltage, phase rotation and protection for equipment prior to start-up. Correct deficiencies before energizing equipment.

4. Control circuit wiring is generally furnished and installed under other Divisions, except that any such wiring shown on Electrical drawings is work of this Division.
5. Provide 120 volt power to temperature control panels (TCP's) supplied and installed by Division 23. Use emergency power sources when available. Coordinate power requirements and panel locations with Division 23 Temperature Controls Contractor.
6. Cooperate and coordinate with the other trades in the installation, connection, and testing of mechanical equipment. Perform work of this section in accordance with equipment manufacturers' instructions.

### 3.13 SUPPORTS AND HANGERS

1. Provide metal framing, supports and braces for equipment installed. Provide floor mounted or free standing supports for equipment not mounted to concrete or block walls. Support panelboards, pull boxes and outlet boxes independently of the conduit.
2. Support single conduit runs by individual hangers.
3. Support multiple conduit runs on trapeze hangers. Do not support conduit on hangers provided for mechanical runs.
4. Provide listed raceway roof support blocks. Wooden support blocks are not acceptable.
5. Securely fasten electrical items including lighting fixtures and their supports to the building structure, unless otherwise indicated. Do not use the ceiling-support wires or ceiling grid to support raceways and cables. Provide independent support wires, secured at both ends.
6. Do not support electrical items including disconnect switches, motor controllers, variable frequency drives, or conduit from the equipment or supports of other divisions.
7. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not support electrical items from the equipment or supports of other divisions.
8. Hanger rods shall be threaded galvanized steel, 3/8" minimum with galvanized double nuts, securely attached to the building structure. Provide sizes, quantities, and connections to safely support imposed loads.
9. Support horizontal and vertical conduits per code and to prevent visible deflections. Conduit shall be firmly fastened within 3 feet of each outlet box, junction box, cabinet or fitting.
10. Provide galvanized steel channel or angle as required for conduit and equipment supports. Provide independent support for items weighing 100 pounds, or more, mounted on gypsum board partitions.

11. Connect rod hangers to the building structure as follows:
  - a. In formed concrete slabs provide anchors by means of cast-in-place inserts.
  - b. To structural steel provide anchors secured to the structure with beam clamps. Clip type (Caddy) conduit supports shall be used only for armored cable.
  - c. To existing work provide expansion bolts if structural steel is not available.
  - d. Powder propelled inserts are not acceptable for this project.
  
12. Support MC cable independent of supports for other mechanical or ceiling support systems.
  - a. Supports shall consist of "Caddy clips" attached to 1/4" threaded rods, steel studs, and beams, and shall be installed in accordance with their listing and loading capacity.
  - b. To existing work provide expansion bolts if structural steel is not available.
  - c. Beam clamps shall be bolt-on C-clamp types, NOT push-on friction-hold Caddy types.
  - d. Do not use "drop wire" or "pencil rod" for supports. Do not use tie-wraps for attachment.
  - e. "Bridle ring" type supports may be used for support of up to six cables, as listed by the manufacturer, where supported by bolt-on C-clamps. Adjust ampacity for more than three current carrying conductors in a cable or for more than twenty bundled cables and ensure compliance with NEC Article 310.15(B)(2)(a) Exception No. 5.
  - f. MC cable shall be routed in a neat and workmanlike manner, parallel, and perpendicular to walls, floors, ceilings, and structure.

### 3.14 HOUSEKEEPING PADS AND RUBBER MATS

1. Provide concrete housekeeping pads under floor mounted electrical equipment.
2. Pads shall be constructed of 3,000 psi concrete.
3. Pads shall be 4 inches high, and 4 inches wider than the equipment in both directions.
4. Rubber mats shall be provided in front of switchboards, motor control centers and substations. The rubber mats shall be 36" wide and 8" longer than the overall length of the equipment.

3.15 SEISMIC REQUIREMENTS - Refer to Section 260548.

3.16 HEAT TRACING

1. The heating cable will be installed per the manufacturer's instructions.
2. Ground fault circuit breakers with a 30 milliamp trip level will be used for all de-icing circuits.
3. Downspout hangers will be used each time the heating cable enters or exits a downspout to protect the heating cable from mechanical damage.
4. Drain spouts shall be provided with continuous de-icing cable loops one foot past the spout entry into the heated space of the building so as to assure a clear drain path.
5. Cable affixing shall be per the manufacturer's recommendation and subject to the approval of the engineer. All epoxies, clips, and tie downs shall be suitable for temperatures from -40°F to 185°F.
6. Install temperature sensor(s) in worst case location in the gutter. Avoid installation of temperature sensors near vents, steam lines or other heated locations.
7. After installation and before and after installing the thermal insulation, subject heater cable to testing using a 2500 VDC megger. Minimum insulation resistance should be 20 megohms or greater regardless of length.
8. Submit test report to the manufacturer's representative to initiate manufacturer's 10 year warranty.

3.17 LOW VOLTAGE LIGHTING POWER SUPPLIES

1. Install according to manufacturer's instructions.
2. Mount where indicated on plans and install in a manner that prevents transmission of vibration into the structure. Refer to Section 260548 for further information.

3.18 OCCUPANCY/VACANCY SENSORS

1. Upon completion of the installation, the system shall be adjusted by the manufacturer's factory authorized technician or the electrician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system.
2. Upon completion of the system adjustment the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION

SECTION 26 05 13 - MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
2. See other Division 26 sections for requirements of medium voltage equipment and systems not included herein.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' technical product data for the following:
  - a. Cable construction specs and data.
  - b. Warranty.
  - c. Installation instructions and recommendations.
  - d. Splicing equipment and kits.
  - e. Terminating equipment and kits.
  - f. Manufacturer's factory test data.
  - g. Recommended field test procedures.
2. After installation and field acceptance testing, submit certified field test reports.

1.05 QUALITY ASSURANCE

1. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
2. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
3. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
4. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
6. Comply with IEEE C2 and NFPA 70.

PART 2 - PRODUCTS

2.01 MEDIUM VOLTAGE CABLE (15 kV)

1. This specification covers single conductor shielded power cable, suitable for installations in underground ducts, conduits, and direct burial in wet locations.
2. Industry Standards
  - a. ICEA S-93-639
  - b. NEMA WC 74
  - c. AEIC CS-8
  - d. UL-1072 (For Type MV-105 Cables)
  - e. ASTM B-496 – Compact Strand
  - f. IEEE 383
3. Conductor
  - a. Uncoated copper, Type MV-105, Class B compressed stranded, minimum 98% conductivity at 20°C.

4. Conductor Screen
  - a. Extruded layer of semiconducting ethylene-propylene rubber thermosetting compound, or high-dielectric stress control layer (Kerite Permashield).
5. Insulation
  - a. Thermosetting compound of ethylene-propylene rubber (EPR) or Kerite HTK, extruded over conductor screen.
  - b. Discharge, ozone, and heat-resistant, rated 105°C for normal operation.
  - c. 133% thickness (220 mils for 15 kV).
6. Insulation Screen
  - a. Layer of semi-conducting ethylene-propylene rubber thermosetting compound extruded over the insulation.
7. Shielding: Copper tape or solid corrugated copper wires, helically applied over semiconducting insulation shield.
8. Overall Jacket
  - a. Provide low smoke, zero halogen (LSZH) thermosetting jacket complying with ICEA T-33-655 and ASTM E662. The jacket shall be free stripping from the insulation screen and shall be printed with the following legends:
    - 1) Manufacturer's Name and Cable Type (Trade Name)
    - 2) Conductor Size
    - 3) CU (Conductor Material)
    - 4) Voltage
    - 5) 133%
    - 6) Insulation Thickness
    - 7) Sequential Footage Number (as applicable)
    - 8) Year of Manufacture
9. Production Tests
  - a. Conductor electrical resistance requirements, insulation resistance, and high voltage tests shall be in accordance with standards.
  - b. Voltage withstand, tested for 5 minutes minimum, shall be 47 kV AC and 94 kV DC, minimum.
10. Shipping
  - a. Cable reels shall be shipped in an upright position supported by both outside flanges.



- b. Water tight seals shall be applied to cable ends to prevent the entrance of moisture during transit, storage and installation.

## 2.02 WARRANTY

- 1. The manufacturer shall warrant that the cable to be furnished is of first class material and workmanship throughout, and that cable is free from defects in design, material or workmanship, for a period of 40 years when installed, terminated and operated within acceptable industry practices. The manufacturer shall agree to replace any defective section of cable free of charge, and extend the same warranty on the replacement cable.

## 2.03 SPLICING EQUIPMENT AND KITS

- 1. Comply with IEEE 404; provide type as recommended by cable or splicing kit manufacturer for the application.
- 2. Splice kits shall be pre-molded cold shrink EPDM rubber, waterproof, capable of passing ANSI C119.1-1986 water immersion tests, heat-shrink type or approved equal, compatible with the cable construction, dimensions, and materials. Taped splices are not acceptable.
- 3. Manufacturers: 3M Electrical Products Division, RTE Cooper Power Systems or Thomas & Betts Corporation Elastimold.

## 2.04 TERMINATIONS

- 1. Type recommended by cable manufacturer to type of cable and installation conditions, including orientation.
- 2. Class 1 (outdoors) or Class 2 (indoors) per IEEE 48. Class 3 is not acceptable.
- 3. Manufacturers: 3M Electrical Products Division, RTE Cooper Power Systems or Thomas & Betts Corporation Elastimold.

## 2.05 SEPARABLE INSULATED CONNECTORS

- 1. Description: Modular system, complying with IEEE 386, with disconnecting, single pole cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- 2. Load-Break Cable Terminators: Elbow-type units with 200 ampere load make/break and continuous current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body; capacitance coupled.
- 3. Dead-Break Cable Terminators: Elbow-type units with 600 ampere continuous current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body; capacitance coupled.

4. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
  - a. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
  - b. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
  - c. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
  - d. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
5. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
6. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

## 2.06 FAULT INDICATORS

1. Indicators: Automatically resetting current type fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
2. Manufacturer: Cooper Power Systems Star Faulted Circuit Indicator, Yale:Power Delivery Products, Inc., current reset type (2.4A minimum), as indicated on drawings.

## 2.07 ARC-PROOFING MATERIALS

1. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
2. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
3. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

4. Manufacturer: 3M Scotch 77 Fire Retardant Arc Proofing Tape with banding of Scotch 69 Glass Cloth Electrical Tape; Plymouth-Bishop 53 Plyarc Arc and Fire Proofing Tape; Industrial Energy Products "Hot-Stop" XLN Tape; A&M Tape Products.

2.08 ACCEPTABLE CABLE MANUFACTURERS

1. Subject to compliance with requirements, provide medium voltage cables manufactured by one of the following:
  - a. General Cable
  - b. Kerite
  - c. Okonite
  - d. Pirelli

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 BASIC MATERIALS.

3.02 INSTALLATION OF MV CABLES AND ACCESSORIES

1. Install cables according to IEEE 576.
2. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
  - a. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
  - b. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
4. Support cables according to Division 26 Section "Basic Electrical Materials"
5. Install "buried-cable" warning tape 12 inches (305 mm) above cables.
6. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
7. Install cable splices at pull points and elsewhere as indicated; use standard kits.

8. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
9. Install separable insulated-connector components as follows:
  - a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
  - b. Portable Feed-Through Accessory: Three.
  - c. Standoff Insulator: Three.
10. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
  - a. Clean cable sheath.
  - b. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
  - c. Smooth surface contours with electrical insulation putty.
  - d. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
  - e. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.
11. Seal around cables passing through fire-rated elements according to other Division "Through-Penetration Firestop Systems."
12. Install fault indicators on each phase where indicated.
13. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
14. Install cables of less than 500 foot length without intermediate splices unless otherwise indicated.
15. Install #4/0 THHN/THWN insulated copper ground conductor with each circuit.
16. Prior to application of termination and splice kits, verify that sufficient space is available in the box, enclosure, or manhole enclosing each such termination or splice.
17. Label covers of pullboxes and junction boxes for systems operating over 600 volts with readily visible lettering at least ½-inch high warning "DANGER HIGH VOLTAGE KEEP OUT."

18. Tag cables where they terminate, splice, tap, enter, and leave manholes, handholes, vaults, switchgear, substations or boxes. Tags shall be brass and approximately 1-1/4" square and 3/32" thick. The marking shall identify the number and size of the conductors in the cable, date, manufacturer, circuit number, voltage, and phase. Minimum 1/4 inch indented lettering and fastened with non-ferrous metal bands approximately 3/8" wide.

### 3.03 FIELD QUALITY CONTROL

1. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
  - a. Perform each visual and mechanical inspection and electrical test stated in InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications (ATS). Certify compliance with test parameters.
  - b. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
  - c. Remove and replace malfunctioning units and retest as specified above.
2. During or immediately after installation of cables and prior to energizing, conduct acceptance insulation testing using high voltage DC methods. Measure leakage current and insulation resistance applying a 15 minute test duration.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this Section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this Section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturer's product data and shop drawings for the following:
  - a. Manholes and Handholes Plans, Details, Sections and Elevations.
  - b. Installation Instructions and Recommendations for Manholes and Handholes.
  - c. Concrete and Rebar Design Data.
  - d. Cable Supports and Accessories.
  - e. Covers and Frames.
  - f. Transformer pad/vault.

PART 2 - PRODUCTS

2.01 GENERAL

1. Provide conduits, ducts, manholes, handholes, and accessories as indicated and specified, and as required for a complete underground raceway system.
2. Provide materials and equipment listed by UL when such equipment is available.

3. Conduit shall be rigid hot-dipped galvanized steel for sweeps and risers and plastic for runs, and as specified on drawings and conforming to the following:
  - a. Rigid Steel: Rigid galvanized steel conduit and fittings shall conform to the requirements of UL 6, ANSI C80-1 and NEC Article 346. Fittings and couplings shall be threaded.
  - b. Plastic duct for concrete encasement shall be Type EB PVC and shall conform to NEMA TC6. Fittings shall conform to NEMA TC9.
  - c. Plastic duct for direct burial shall be Schedule 40 PVC and shall conform to NEMA TC2 and NEC Article 347.
4. Pull rope shall be synthetic and having a minimum tensile strength of 500 pounds.
5. Grounding and bonding equipment shall be in accordance with UL 467. Ground rods shall be copper clad steel, 3/4 inch in diameter and 10 feet long, unless otherwise indicated. Provide #3/0 bare copper secured to the four perimeter walls and bond metallic cable racks, ladders and accessories to the ground rod.

#### 2.02 MANHOLES & HANDHOLES (H-20/TRAFFIC RATED)

1. Manholes and handholes shall be precast reinforced concrete, manufactured by a firm with a minimum of five (5) years successful experience in such structures of similar sizes, designed in accordance with applicable AASHTO and ACI standards as certified by a registered professional structural engineer. Design and construction shall be suitable for the indicated locations and applications.
2. Manhole and handhole inside dimensions shall be as shown on drawings, except that manufacturer's next larger standard sizes may be provided where site conditions allow. Provide duct bank windows coordinated with duct bank routing and to match ductbank pitch and drainage requirements.
3. Provide manhole roof with 38 inch diameter opening in center. Provide precast concrete neck or riser segments of suitable height (12 inches minimum) to coordinate ductbank to slope and drain away from building foundations, to match top of frame flush with finished grade and duct bank depth with entrance window. Provide 32 inch diameter cast steel frame and cover suitable for roadway installation, minimum H-20 vehicular traffic loading.
4. Handhole covers shall be vault style, galvanized steel, secured by bolts and sized to match full interior opening of handhole. Provide angle frame in bottom section or extension section of handhole to receive cover. Cover shall be suitable for roadway installation, minimum H-20 vehicular traffic loading. Provide inserts to lift cover. Provide precast concrete extension sections of suitable height (6 inches minimum) to coordinate ductbank to slope and drain away from building foundations and duct bank depth with entrance window. Include top section adjusting bolts to match top of frame flush with finished grade.

5. Provide manhole and handhole floors with 12 inch diameter sump hole in one corner, and 1 inch diameter ground rod hole in another corner.
6. Provide manhole walls with a recessed 3 inch diameter pull eye, made of 3/4 inch galvanized rebar, opposite each duct window. Provide handhole with recessed 3/4 inch galvanized pulling iron center in floor. Provide threaded inserts as required for installation of indicated cable racks in manholes and handholes.
7. Provide non-metallic cable racks minimum 120 lbs. capacity per arm on 48 inch centers with adjustable 10 inch arms, 3 arms per rack for manholes. For handholes provide racks centered on the walls with adjustable 6 inch arms and 2 arms per rack; Underground Devices, Inc. or pre-approved equivalent.

2.03 HANDHOLES (NON-TRAFFIC BEARING)

1. Non-traffic bearing handholes shall be non-metallic polymer (Quazite or pre-approved equal) of indicated minimum dimensions, with full-size covers.
2. Provide handholes with minimum 2 inch diameter drain hole in bottom.

2.04 IN-GROUND CAST BOXES

1. Provide vehicular traffic bearing cast polymer resin concrete or non-traffic bearing cast fiberglass underground junction and pull boxes for flush mounting as required by conditions and as shown on drawings.
  - a. Manufacturers: Cast iron or aluminum - O-Z Gedney, Crouse-Hinds; Polymer concrete - Quazite or Synertech; Cast fiberglass - PenCell; or approved equivalents.

2.05 TRANSFORMER VAULT/PAD – Refer to Section 262700

2.06 COVERS

1. Manhole and handhole covers shall be provided with two (2) pickholes, 180° apart.
2. Manhole and handhole covers shall be cast with the lettering "ELECTRIC", "TELEPHONE" OR "CATV", as appropriate.
3. Non-metallic polymer or cast fiberglass handhole box covers and cast iron or aluminum in-ground box covers shall be non-skid with neoprene gasket and stainless steel cover screws. Cover legend: "ELECTRIC", "TELEPHONE", "CATV" and as shown on drawings.



PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 Basic Materials.

3.02 UNDERGROUND INSTALLATION

1. Underground installation shall conform to National Electrical Code and National Electrical Safety Code.
2. Underground duct with concrete encasement shall be constructed of individual conduits encased in concrete. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover around ducts. Separate conduits by a minimum concrete thickness of 2 inches, except electric conduits shall be separated from low voltage or signal system conduits by a minimum concrete thickness of 6 inches if combined in the same envelope.
  - a. The top of the concrete envelope shall have a minimum burial depth no less than that permitted by NEC Article 300, Section 300.50, and shall have a maximum depth to the top of the ductbank of 30 inches below grade.
  - b. Duct banks shall have a continuous slope downward toward manholes and handholes and away from building foundations with a minimum pitch of 3 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet; sweep bends may be composed of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter, and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.
  - c. Terminate conduits in end-bells where ducts enter manholes and handholes. Stagger the joints of the conduits by rows and layers to strengthen the duct bank. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked-in duct bank. Install spacers per manufacturer's instructions. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring.
  - d. Connect to existing concrete encasement, foundations and concrete structures using dowels. Connect to manhole and handhole walls using dowels.
  - e. Prior to installing cables in underground duct banks, and plugs and pullropes in empty ducts, ensure that each duct is clear after rodding with a mandrel and left clean and dry.

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**UNDERGROUND ELECTRICAL WORK**  
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- f. Conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a pullrope having 3 feet of slack at each end of unused or empty conduits.
  - g. Where it is necessary to cut the tapered end on a piece of conduit at the site, the cut and/or taper shall be made with a special tool or a lathe, so that the new taper matches the taper of the particular conduit being used.
- 3. Concrete for electrical work shall conform to the requirements of Division 3.
  - 4. Underground duct without concrete encasement shall be constructed of individual conduits and shall be direct buried in the earth upon a 6 inch deep sand or granular bed and cover. Direct-buried conduits shall have a minimum burial depth no less than that permitted by NEC Article 300, Section 300.50, and shall have a maximum depth to the top of the conduits of 36 inches below grade.
  - 5. Provide detectable tape manufactured specifically for warning and identification of buried cable and conduit. See Specification Section 260500 for details. Bury tape with the printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.
  - 6. Excavating, backfilling, and compacting shall be as specified in Division 2 of this specification.
  - 7. Set manholes, handholes and in-ground cast boxes on a bed of minimum 6 inch deep compacted granular fill. Installation and assembly shall be per manufacturer's instructions.
  - 8. Set handhole access covers flush with finished grade.
  - 9. Install grout, caulk, and/or sealant as required at construction joints and duct entries to make watertight.
  - 10. Fireproof cables in manholes, handholes and vaults as shown on drawings using fireproofing tape in half-lapped wrapping. Extend fireproofing one inch into duct. Provide fireproofing tape by International Protective Coatings Corp. or approved equal.

END OF SECTION

SECTION 26 05 48 - ELECTRICAL VIBRATION & NOISE CONTROL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Install electrical equipment in a manner that prevents transmission of objectionable vibration into the structure. This isolation includes, but is not limited to, resilient mounting of transformers, dimmer racks, conduit, UPS's, diesel generators, inverters, motor starters, remote fluorescent fixture ballast cabinets, and variable frequency motor controllers. The vibration isolation manufacturer shall provide supervision to ensure proper application, installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer shall make a final inspection and report. The Contractor shall submit this report to the Owner's Representative, in writing, certifying the proper performance of the installation.

1.02 SUBMITTALS

1. Submit NEMA sound power ratings for transformers, dimmer racks, UPS's, gas/diesel generators, motor starters, remote fluorescent fixture ballasts, and variable frequency motor controllers.
2. Submit shop drawings for conduit passing through isolated block-outs in structure.
3. Submit shop drawings for resilient penetration sleeve/seals field fabricated or prefabricated.
4. Submittals shall show required efficiency, designed deflection and outside diameter of springs, when pertinent, and installation guidelines.
5. Submit shop drawings for neoprene mounts clearly marked to show equipment tag and weight, mount type and size, actual isolator deflection and maximum rated load for every mount. Submittals based on static load are not acceptable.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATIONS - GENERAL

1. Electrical equipment shall be mounted in accordance with the specifications below and with the specific requirements shown in the equipment schedules. The vibration isolation manufacturer shall provide supervision to ensure proper application, installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer shall make a final inspection and report. The Contractor shall submit this report to the Architect, in writing, certifying the proper performance of the installation.

2. The isolation manufacturer shall supply unit isolators, complete rails, where required, and shall be responsible for the selection of vibration eliminators and shall guarantee to meet the requirements of this specification.
3. Vibration isolators shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated, or phosphate primed and finish painted with rust-resistant enamel. Nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with metal etching primer and painted with rust-resistant enamel. Isolators exposed to the weather shall have steel parts hot-dipped galvanized. Nuts, bolts and washers shall be cadmium plated. Spring components shall be cadmium plated and neoprene coated.
4. Vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
5. Isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
6. The ratio of lateral to vertical stiffness shall be not less than 0.9 nor greater than 1.5.
7. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than + 10%.
8. Neoprene mountings shall have a shore hardness of 40 to 65, after minimum aging of 20 days or corresponding oven-aging.

## 2.02 MOUNTINGS

1. Type A, Seismic, Floor Mount - horizontal and vertical rated in tension, compression and shear, consisting of bridge-bearing neoprene, ductile iron housing, top 'N' cap screw with washer, and minimum four bottom anchor holes. Mountings shall have a minimum static deflection of 0.5 inch. Include structural steel channel rails with leveling bolts for rigid connection to the equipment. Basis of design: Mason Industries Type BR and Type DNR rails or pre-approved equal by Kinetics Noise Control, Amber Booth or Korfund.
2. Type B, Seismic, Spring Mount – restrained single or multiple spring mount consisting of welded corrosion-resistant steel restraint, 'CS' cap screw and adjustment bolt, and base anchor holes as required. Basis of design: Mason Industries Type SLR or pre-approved equal by Ace Mountings Company or Amber Booth.
3. Type C, Seismic, Suspension Mount - horizontal and vertical rated in tension, compression and shear, consisting of bridge-bearing neoprene, steel housing, top 'CS' cap screw with washer, and minimum six bottom anchor holes. Mountings shall have a minimum static

deflection of 0.5 inch. Include structural steel channel rails with leveling bolts for rigid connection to the equipment. Basis of design: Mason Industries Type RBA/RCA and Type DNR rails or pre-approved equal by Kinetics Noise Control, Amber Booth or Korfund.

4. Type D, Seismic, Wall Mount – bridge neoprene and electro-galvanized steel sleeve and washer type isolator with seismic anchor stud. Basis of design: Mason Industries Type PB or pre-approved equal by Kinetics Noise Control, Amber Booth or Korfund.
5. Flexible Connectors
  - a. Penetrations of sound-rated walls, floors, and ceilings in sound-critical spaces shall be specially sealed in accordance with the requirements as outlined on the drawings.
  - b. Provide isolation couplings with molded neoprene sleeve, bonding jumper and hot-dip galvanized finish ductile iron end fittings for rigid metal conduit and intermediate metal conduit; Appleton Type CF-1, OZ Gedney Type DX or pre-approved equal.

2.03 ISOLATION SCHEDULE

EQUIPMENT TYPE	ISOLATION TYPE
Floor Mounted Transformers	A
Floor Mounted Dimming Panels	A
Floor Mounted Unit Power Conditioners	A
Floor Mounted UPS's & Inverters	A
Suspended Transformers	C
Diesel/Gas Generators	B
Wall Mounted Equipment *	D

\* wall mounted equipment shall include dimmer panels, transformers, and all controls/control panels with transformers, contactors, relays, fans, and/or moving parts

2.04 RESILIENT PENETRATION SLEEVE/SEAL

1. Resilient penetration sleeve/seals shall be field fabricated from a pipe or sheet metal section that is 1/2-inch to 3/4-inch larger than the penetrating element in all directions around the element and shall form a sleeve through the construction penetrated. Refer to drawing detail. Prefabricated sleeves shall be submitted for review prior to installation.

2.05 OUTLET BOX PAD

1. Outlet box pads shall be field installed to acoustically isolate spaces. Refer to drawing details and manufacturer's instructions. Box pad manufacturer shall be Harry A. Lowry & Associates, Inc., Sun Valley, CA 818-768-4661 or pre-approved equal by Amber Booth or Korfund.

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 Basic Materials and Methods.

3.02 INSTALLATION

1. Install vibration isolation devices and systems in accordance with the manufacturer's instructions.
2. Floor Mounted Equipment to include:
  - a. 4-inch thick concrete housekeeping pads over entire floor area of supported equipment.
  - b. Supporting vibration isolation devices and bases.
  - c. Keying with hairpins as required to be integral with the structural slab.
  - d. Incorporating pre-approved seismic restraint anchor plates flush with the top of the housekeeping pad.
3. Concrete per specification Division 3 describing requirements.
4. Verify installed isolators and mounting systems permit equipment motion in all directions.
5. Adjust or provide additional resilient restraints to limit startup equipment lateral motion to 1/4-inch.
6. Prior to startup, clean out foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.
7. No rigid connections between equipment and building structure shall be made that degrades the vibration isolation system herein specified.
8. Do not install any equipment, piping or conduit that makes rigid contact with the "building" unless permitted in this specification. "Building" includes, but is not limited to slabs, beams, columns, studs and walls. Use flexible conduit for connections to equipment vibration isolated with springs or neoprene (transformers, dimmers, pumps, fans, chillers, boilers, etc.). Flexible conduit shall be minimum of 25% greater length than the separation between the isolated equipment and the termination of rigid conduit. Install flexible conduit to be slack and not to exceed the manufacturer's minimum recommended bending radius. For conduit sizes greater than 2" diameter, use pre-manufactured flexible conduit connectors instead of flexible conduit.
9. Use flexible conduit or a flexible conduit connector at every location where conduit crosses a building expansion or isolation joint.
10. Resiliently mount to structure conduit connected to vibration isolated electrical equipment for a distance equal to 200 conduit diameters and for any additional extent

indicated on the Drawings. Wrap conduit with 1" Armaflex prior to restraining with wall-mounted clamp.

11. Provide steel sleeve, grouted rigidly in place for conduit penetrations through walls, floors, and ceilings of mechanical equipment rooms, machine rooms, electrical equipment rooms and elevator equipment rooms. Make inside dimension of sleeve ½-inch to ¾-inch greater than outside dimension of penetrating item on all sides. The sleeve shall extend 1-inch beyond the penetrated construction on each side. The penetrating element shall pass through the sleeve without contacting the sleeve. Pack annular space to full depth of penetration with intumescent fire-rated sealant to form an airtight seal. Refer to Section 260000 and drawing details.
12. Coordinate work with other trades to avoid rigid contact with the "building". Inform other trades following, such as plastering, drywall, electrical or sheet metal, to avoid any contact that would reduce the vibration isolation.
13. Bring to the Owner's Representative's attention, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the contractor's expense.
14. Correct, at no additional cost, installations that are deemed defective in workmanship or material as a result of project completion inspection or subsequent inspections due to owner complaints within a period of one year following acceptance.
15. Position isolators:
  - a. Close to building structure.
  - b. Between building structure and supplementary steel if required.
  - c. Not to contact acoustic rated walls.
16. Suspend isolators from rigid and massive support points.
17. Adjust isolators to eliminate contact of the isolated rod with the hanger rod box retainer or short circuiting of the spring.
18. Provide outlet box pads for electrical, telecommunications, fire alarm, security boxes and the like where indicated on the drawings.
  - a. There shall be a separation of 24" between centerlines of outlet boxes or receptacles set into opposite sides of the wall. Conduit connecting such boxes shall be flexible and shall provide 6" slack per 24" of run.
  - b. In a double wall, boxes in opposite sides of the wall shall be located 24" on center, minimum. Effectively, this means that boxes on the same side of the wall will be 48" apart if there is a box between them on the other side of the wall.

- c. The boxes shall be treated to reduce sound transmission. Unused knock-out holes shall be plugged with knock-out caps or spot welded closed. The openings or cutouts in the walls to receive the boxes/receptacles shall be made no more than 1/4" oversize to allow a 1/8" gap all around. The flanges shall be perimeter sealed with acoustical caulking, prior to the boxes/receptacles being inserted.
- d. Outlets installed in gypsum board only partitions (no CMU in construction) in noise critical spaces will require that the outlet be wrapped on five sides with an acoustical pad. The pad is a polybutadiene-butyl material with a self-adhesive backing. Adhere pads to boxes before mounting box or attaching conduit according to manufacturer's instructions. Install plaster rings and tightly secure before completely wrapping pad around gypsum board face of box. Fill any remaining voids between gypsum board and box with non-hardening acoustical sealant.

19. General Equipment Isolation and Seismic Restraint:

- a. Provide 2-inch operating clearance between concrete inertia bases and housekeeping pad and 1-inch clearance between equipment or structural bases and housekeeping pad.
- b. Isolation mounting deflection (minimum) as specified or scheduled on manufacturer's certified drawings.
- c. Position equipment, structural base and concrete bases on blocks or wedges at proper operating height.
- d. Electrical conduit connections to isolated equipment shall be looped or installed with flexible conduit to allow free motion of isolated equipment.
- e. Install equipment directly on isolation system. Support rails between the equipment and isolators should not be used.
- f. Position corner or side seismic restraints with equipment operation for operating clearance and weld or bolt seismic restraint to seismic anchor plates in housekeeping pad.

3.03 SEISMIC REQUIREMENTS

- 1. Adequately anchor floor mounted equipment to floor slab or housekeeping pad to resist 0.5g (minimum) horizontal accelerations. Where necessary, also provide U-channel bracing to structural steel or slab above.
- 2. Wall mounted enclosures and equipment on stud partitions or non-reinforced block walls shall be mounted via two (2) slab-to-slab steel U-channels anchored to the wall every 24 inches O.C., and anchored to the floor and ceiling slabs.



3. Where possible, conduit, cable tray & raceway hangers shall be less than 12 inches long. Where hangers are 12 inches or more in length, and conduit size is 2-1/2 inches or more and for cable tray, provide longitudinal and transverse sway bracing. Seismic restraints spacing shall be in accordance with hanger spacing.
4. Provide sway bracing for those conduit runs containing emergency and critical power and lighting, fire alarm circuits, other life safety systems regardless of conduit size.
5. Recessed lighting fixtures shall be independently supported from the structure above unless the suspended ceiling is seismic-rated and the fixtures are provided with earthquake clips.

END OF SECTION

SECTION 23 09 23 - REMOTE LIGHTING CONTROL

PART 1 - GENERAL

1.01 SUMMARY

1. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. 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.
2. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
3. Refer to the Phasing documents for warranty initiation, time frame, and duration. The contractor shall provide warranty periods as noted here-in.

1.02 DESCRIPTION OF WORK

1. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans and as further defined herein.
2. The system shall include but not be limited by the following list: Pre-wired, microprocessor controlled relay panels with electrically held, electronically latched relays and "Smart Panelboards" using solenoid operated thermal magnetic breakers controlled via a complete list of communications based accessories including digital switches, digital photocells, Digital Time Clock (DTC) and interface cards to dimming systems, building automation systems, thermostats, and any contact closure or analog based device. The type of lighting control equipment and wiring specified in this section is covered by the description: Microprocessor Controlled Digital Relay Lighting Control system with RS 485 Bus communications. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring. They are not the work of this section.

1.03 SUBMITTALS

1. The information shall be provided for review in a phased submittal process. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase the project is beginning it will be returned, not reviewed. This is a phased project and the Lighting Control System is required to be submitted to the Engineer in a manner that reflects the phasing of the project. The following shall be provided for each area under the present phase of construction for this project:

2. Section 260000 – Shop Drawing Requirements.
3. Shop Drawings: Submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, photocells and other interfaces. Drawings to indicate exact location of each device.
4. Product Data: Submit for approval 6 copies of manufacturer's data on the specific lighting control system and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at manufacturer facility. Submit a complete bill of materials with part numbers, description and voltage specifications.
5. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component if it differs from that illustrated in the riser diagram in these specifications. Submittals that show typical riser diagrams are not acceptable.

#### 1.04 QUALITY ASSURANCE

1. Products shall be manufactured by Greengate, Lighting Control & Design, Lutron or pre-approved equal. Such firms shall be regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Any product other than those listed in this specification must be pre-approved a minimum of two weeks before bid time. No exceptions.
2. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.
3. A licensed electrician shall functionally test each system component after installation, verify proper operation and confirm that all relay panel and switch wiring conform to the wiring documentation. The Electrical Contractor (EC) is required to phone LC&D a minimum of 7 days before turnover for system checkout. At time of LC&D contact, all components to include phone line to modem must be installed, powered and operational.
4. Comply with NEC and all local and state codes as applicable to electrical wiring work. Lighting control panels shall be ETL listed to UL 916. LCPs controlling emergency circuits shall be ETL listed to UL 924.
5. The lighting control system shall also be listed or approved by all national, state and local energy codes to include but not limited to California Title 24 and Wisconsin Comm63.

#### 1.05 MAINTENANCE MATERIALS

1. Division 1 - Execution Requirements: Spare parts and maintenance products.

2. Provide 4 spare relays per LCP, except for Micro panels.
3. Provide extra CD version of manufacturers operating software to include graphical interface software.
4. Provide 2 extra sets of as-built and operating manuals.

#### 1.06 SUBSTITUTIONS

1. Substitutions refer to specification 260000. Base bid must reflect the specified equipment. A product must go through the following process before being approved as a substitution:
  - a. A list of substitutions shall be provided to the owner as an attachment to the bid form. Submit along with bill of material, CD of proposed operating system, and a one line diagram of the system configuration proposed indicating the type, size and number of conductors between each component if it differs from that illustrated in the riser diagram in these specifications.
  - b. The list will be reviewed by the owner and the engineer to determine whether the equipment meet the project needs

### PART 2 - PRODUCTS

#### 2.01 MATERIAL AND COMPONENTS

1. Relay Panels: Panels shall be made up of the following components:
  - a. NEMA rated enclosure with screw cover or hinged door. Rain tight or oil tight and other NEMA rated versions available.
  - b. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.
  - c. LCP input power shall be capable of accepting 120v or 277v without rewiring
  - d. Control electronics in the low voltage section shall be capable of driving 2 to 48 relays, control any individual or group or relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control Normally Open (NO) or Normally Closed (NC) relays.
  - e. Lighting control system shall be digital and consist of a Master LCP with up to 48 individual relays, Slave LCPs with up to 48 individual relays in each panel, a Micro LCP with up to 4 individual relays, digital switches and digital interface cards (see interfaces). All system components shall connect and be controlled via a single Category 6e, 4 twisted pair cable, providing real time two-way communication with each system component. Analog systems are not acceptable.
  - f. Lighting control system shall have the capability to output 4 independent 0v to 10v signals in a Micro LCP. Micro LCP shall control 4 independent 20a

fluorescent lighting circuits. Each circuit shall have an adjustable fade rate and take inputs from a wall device, DTC system controller or a digital photocell.

2. Standard Output relays
  - a. Electrically held, electronically latched SPST relay.
  - b. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #10AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
  - c. Rated at 20 Amp, 277VAC Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.
  - d. Relays to be rated for 250,000 operations minimum at 20a lighting load, use Zero Cross circuitry and be Normally Closed (NCZC). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.
  - e. Relay types available shall include: Normally Open (NO) relay rated for 100,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.
  
3. Switches
  - a. All switches shall be digital and communicate via RS 485. Contact closure style switches shall not be acceptable. Any switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
  - b. Switches shall be available in 1 through 6-button version with engraveable buttons, red LED annunciation for each button and a constantly on green LED locator.
  - c. Switches may be programmed to be Momentary ON, Momentary OFF, Toggle or Maintained. These functions shall be able to be changed locally (at the DTC or a PC) or remotely, via modem.
  - d. Contractor to verify all switch types and quantities per plans and specifications.
  - e. Accessories available to include digital key switch and digital key enable switch.
  
4. DTC - Digital Electronic Time Clock
  - a. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.
  - b. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
  - c. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.

- d. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.
  - e. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.
  - f. Software pre-installed with standard Unity Graphical Management Software or Greengate graphical touch software, Keeper enterprise with vision touch, (11) pages. GMS software shall provide via local BMS/DDC PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone.
  - g. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.
  - h. DTC shall provide system wide timed overrides. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.
5. System to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans.
- a. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
  - b. Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
  - c. An exterior (PCO) or interior (PCI) photocell that provides readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through programming only. Photocells which requires the use of setscrews or which must be programmed at the photocell control card shall be not acceptable.
  - d. An interface card that allows the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats to be able to done locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
  - e. A voice prompted telephone override interface module. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.
  - f. Software pre-installed to run Unity GX Graphical Management Software or Greengate graphical touch software, Keeper enterprise with vision touch, (11) pages. GMS-GX software shall provide via local BMS/DDC PC a visual representation of a specific area or the total area of the project. GMS full graphic pages shall be designed to the owner's specifications. Provide 11 GMS pages and no less than 100 control points Furnish and Install LCD "Unity GX" graphical interface software including (1) graphical pages per floor per building wing and (2) for the site, for a total of twenty (11) pages. Provide a total (1) control point per circuit, no less than 100 points. Relay to control points and zoning scheduling and coordination shall be determined during shop drawings.

- g. Direct digital interface to Smart Panelboards. Relay panel and Smart Panelboard circuits shall appear on the system software as similar, yet distinct, items and maintain all functions and features of the system software to include GMS pages.
  - h. Direct digital interface to DMX 512 based systems. Lighting control system shall provide 14 global DMX commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 6e, 4 twisted pair cable, providing real time two-way communication between lighting control system and a DMX based system.
6. Smart Panelboards shall be made up of the following components:
- a. NEMA rated enclosure with hinged door, available with main lug or main breaker and in voltages of 120/240, 208Y/120 and 480Y/277. Continuous main current ratings as indicated on the panelboard schedule on the drawings. Minimum AIC rating to be 200,000. Rain tight or oil tight and other NEMA rated versions available.
  - b. Control electronics mounted internally to each smart panelboard shall be capable of driving up to 42 controllable breakers, control any individual or group of breakers, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each breaker and every zone and be able to control a Micro Relay panel located downstream of non-controllable breaker.
  - c. Lighting control system shall be digital and consist of a Master LCP with up to 31 controllable, Slave LCPs with up to 42 controllable breakers in each panel, a Micro LCP with up to 4 individual relays, digital switches and digital interface cards (see interfaces). All system components shall connect and be controlled via a single Category 6e, 4 twisted pair cable, providing real time two-way communication with each system component. Analog systems are not acceptable.
  - d. Lighting control system shall have the capability to output 4 independent 0v to 10v signals in a Micro LCP. Micro LCP shall control 4 independent 20a fluorescent lighting circuits. Each circuit shall have an adjustable fade rate and take inputs from a wall device, DTC system controller or a digital photocell.
7. Controllable Breakers
- a. Solenoid operated thermal magnetic breakers.
  - b. Ratings of 120/240V AC; 15, 20 and 30 Amp; 1- and 2-pole, 277/480V AC, 15, 20 and 30 amp: 1 and 2-Pole
  - c. Rated at 20 Amp, 277VAC Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.
8. Relays
- a. Rated at 20 Amp, 277VAC Ballast, Tungsten, HID, 1 HP at 120 Vac, 2 HP at 240 Vac.

- b. Relays to be rated for 250,000 operations minimum at 20a lighting load, use Zero Cross circuitry and be Normally Closed (NCZC). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.
9. Switches
- a. All switches shall be digital and communicate via RS 485. Contact closure style switches are not acceptable. Any switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
  - b. Switches shall be available in 1 through 6-button version with engraveable buttons, red LED annunciation for each button and a constantly On green LED locator.
  - c. Switches may be programmed to be Momentary ON, Momentary OFF, Toggle or Maintained. These functions shall be able to be changed locally (at the DTC or a PC) or remotely, via modem.
  - d. Contractor to verify all switch types and quantities per plans and specifications.
  - e. Accessories available to include digital key switch and digital key enable switch.
  - f. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.
10. DTC - Digital Electronic Time Clock
- a. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.
  - b. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
  - c. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.
  - d. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.
  - e. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.
  - f. DTC shall provide system wide timed overrides. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.
  - g. Software pre-installed to accept standard Unity Graphical Management Software (GMS) pages. GMS software shall provide via local BMS/DDC PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone.



- h. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.

Operator Station: Provide (2) Microcomputer stations with printers located in the (1) in the maintenance office and (1) in the security office, as specified below:

Workstation: IBM-compatible microcomputer with minimum configuration as follows:

- Processor: Intel Core 2 Duo 2.2 GHz or equivalent.
- Random-Access Memory: 3.0 GB.
- Graphics: Super video graphic adapter (SVGA), minimum 1280 x 1024 pixels, 8.0-MB video memory.
- Monitor: 19 inches flat-panel lcd, wide screen, color, with maximum 0.28-mm dot pitch.
- Keyboard: QWERTY, 105 keys in ergonomic shape.
- Floppy-Disk Drives: 1.44 MB.
- Hard-Disk Drive: 160.0 GB.
- DVD/CD-ROM Drive: 16x (minimum)
- Read-Write DVD/CD-ROM Drive: 16x (minimum)
- Ports: (4) USB, (1) Serial, (1) parallel, and mouse ports.
- Mouse: "Intellimouse" Two button with wheel.
- Network Card: Linksys Ethernet 10/100 PCI card or equivalent
- Operating System: Microsoft Windows XP-Professional or later.
- BACnet Conformance: Workstation shall support BACnet device and have minimum capabilities defined in PICS for the following areas:
  - Network.
  - Functional groups.
  - Standard application services supported.
  - Standard objects supported.
- Printer: Color, laser type as follows:
  - Print Head: 1440 x 1440 dpi photoquality color resolution (minimum).
  - Paper Handling: Minimum of 100 sheets.
  - Print Speed: Minimum of 8 ppm in black and 4 ppm in color.
  - Provide (2) MGE XE 1500 uninterruptible double conversation power supply.

11. System to have available all of the following interfaces.  
Verify and install only those interfaces indicated on the plans.

- a. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.
- b. Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.
- c. An exterior (PCO) or interior (PCI) photocell that provides a readout on the DTC screen in number values analogous to foot-candles. Each photocell shall provide a minimum of 14 trigger points. Each trigger can be programmed to control any relay or zone. Each trigger shall be set through programming only. Photocells which require the use of setscrews or which must be programmed at the photocell control card shall be not acceptable.

- d. An interface card that allows the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats to be able to done locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
- e. A voice prompted telephone override interface module. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.
- f. Software pre-installed to run Unity GX Graphical Management Software (10) pages. GMS-GX software shall provide via provided (2) PC a visual representation of a specific area or the total area of the project. GMS full graphic pages shall be designed to the owner's specifications. Provide \_11\_ GMS pages
- g. Direct digital interface to DMX 512 based systems. Lighting control system shall provide 14 global DMX commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 6e, 4 twisted pair cable, providing real time two-way communication between lighting control system and a DMX based system.

## 2.02 MODES OF OPERATIONS

1. DTC – Digital Electronic Time Clock: DTC shall control any relay or group of relays by the following modes: ON only, OFF only, Maintained, Maintained with timer and OFF sweep warning (Blink warn), Maintained with timer (No blink warning). Timers adjustable from 1 minute to 4 hours. When the scheduled program in the DTC is ON the associated timers are disabled. When the scheduled program in the DTC is off and a relay or zone is overridden, the DTC will put that relay or zone into the timer mode and automatically sweep off at the end of the programmed timer period (Maximum 2-Hour Timed Override). All DTC settings, schedules, photocell trip points, temperature settings, longitude and latitude, time zone offset to sunrise and sunset and any other owner settings shall be able to be changed though software locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet. No exceptions.
2. Switches: All system switches shall be digital and daisy chained on a single category 6e, 4 twisted pair cable with all LCPs. Any switch button shall be able to control any relay or group of relays anywhere on the system in the following modes: ON, OFF, Mixed (Some relays ON some OFF), Toggle (first push ON, next OFF etc.) Maintain. Timer ON with a time set from 1 minute to 4 hours. Timer ON with Off sweep warning, (Blink warning 5 min or as programmed prior to OFF sweep.) Timer ON with Horn Warning (Horn output turns ON for the warning 5 min or as programmed prior to OFF sweep.) Any switch function shall be able to changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet. Any relay, group or zoned that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

**PART 3 - EXECUTION**

**3.01 EQUIPMENT INSTALLATION**

1. Mount relay control cabinets adjacent to respective lighting panelboard. Cabinet shall be surface or flush mount, per plans. Wiring between relay control cabinet and panelboards to be per local codes and acceptable industry standards. Under no circumstances will any extra be authorized for payment to the EC or GC due to the EC's lack of knowledge or understanding of any and all prevailing codes or specified manufacturer's installation requirements. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of the installing contractor.
2. Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. EC is specifically responsible to supply and install the required low voltage cable, Category 6e, 4 twisted pair, with pre-assemble RJ45 connectors and snagless boots (commonly referred to as a Cat 6e patch cable) between all switches and panels. Field-test all Cat 6e patch cable with a recognized cable tester. All low voltage wire to be run in conduit, per local codes.
3. Wiring
  - a. Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.
  - b. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
  - c. Place manufacturer supplied "terminators" at each end of the system bus per manufacturer instructions.
  - d. Neatly lace and rack wiring in cabinets.
  - e. Plug in Category 6e, 4-twisted pair patch cable that has been field tested with a recognized cable tester at the indicated RJ45 connector provided with each lighting control device, per manufacturer instructions.
  - f. Use Category 6e, 4 twisted pair patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information. Use shielded cable for dry contact inputs to lighting control system.
  - g. Do not exceed 4000ft-wire length for the system bus.
  - h. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.
  - i. The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. EC to wire per manufacturer instructions.

3.02 DOCUMENTATION

1. Each relay shall have an identification label indicating the originating branch circuit number and panelboard name along with the relay number as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.
2. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

3.03 SERVICE, SUPPORT AND MAINTENANCE

1. Start Up: EC shall contact LC&D at least 7 days before turnover of project. LC&D will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required by LC&D. LC&D will provide (4) weeks, for the On-Site programming and Training for the lighting control system. EC shall be available at the time of On-Site visit to perform any corrections required by LC&D. EC is responsible for coordinating with GC and the owner the installation of a dedicated telephone line or a shared phone line with A/B switch. Phone jack to be mounted within 12" of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP. EC shall furnish and install telephone jack and wiring to the telephone demarc, located in room A121. The contractor shall be responsible for terminations. The contractor shall coordinate with the owner the designated telephone line.
2. The warranty shall be for no less than a period of two years for each component, The two year warranty period begins from the date of substantial completion for the phase which the equipment and components become operational and are accepted by the commissioning agent.
3. Telephone factory support shall be available at no additional cost to the EC or Owner both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional programming via modem as required by the EC or Owner for the operation life of the system. Manufacturer warrants that the DTC software can be upgraded and monitored remotely. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.
4. Provide a factory technician for on-site training of the owners' representatives and maintenance personnel. Coordinate timing with General Contractor. Provide 5 days of factory on-site training for each phase of this project.

5. The contractor shall maintain, test, and clean the equipment and components of the lighting control system as recommended within this section and per the manufacturer's maintenance criteria. The contractor shall furnish, install and replace with new, the equipment and components required to keep the lighting control system operational during the entire length of the project. The length or duration as outlined in the phasing documents shall be the duration of the project. Maintenance shall begin when the commissioning agent's acceptance that the lighting control system is in substantial compliance for operation phase 1.0 of this project. The maintenance shall be complete after the final test and equipment replacement of the equipment has been performed as part of the final acceptance by the commissioning agent after the final (last) phase of the project is accepted for substantial completion. Refer to the phasing documents for additional information. The G.C. shall provide the dates.

#### 3.04 CLEANING AND TESTING

1. Division 1 - Execution Requirements: Final cleaning.
2. Remove dirt and debris from all LCP enclosures.
3. Clean photocell lens as recommended by manufacturer.
4. Clean all switch faceplates.
5. The lighting control equipment shall be tested every 2 months for proper operation. Malfunctioning equipment replacement shall be furnished and installed at no additional cost to the owner. A final test and equipment replacement of the equipment shall be performed as part of the final acceptance by the commissioning agent after the final phase of the project is accepted for substantial completion. Refer to the phasing documents for additional information.

#### 3.05 INSTALLATION

1. Install and connect lighting controls, switches, and components in strict accordance with manufacturer's instructions and wiring diagrams.
2. Interface the low voltage control system with the building management/automation system (BMS) for automatic time control of the connected lighting. Coordinate requirements with Division 23.
3. Locate and adjust photoelectric controls for proper dusk to dawn operation of outdoor lights.
4. Perform initial programming of time switches. Coordinate requirements with the Owner.

3.06 TESTING AND DEMONSTRATION

1. After energization, demonstrate the operation of lighting controls to the Architect and Owner. Make any corrections or minor modifications as directed.

END OF SECTION

SECTION 26 09 43 - ARCHITECTURAL DIMMING SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Division shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this Division as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this contract in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
2. Refer to Lighting Consultant's Section 265000, for requirements not included herein.
3. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
4. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.

1.03 WORK INCLUDED

1. The work under this Section shall include labor, material, equipment, plant, services and administrative tasks required to complete and make operable the electrical work related to architectural dimming systems for the areas as shown on the drawings and specified herein.
2. The contractor shall furnish and install architectural dimming and switching control systems and components as necessary to provide a complete operational installation, including but not limited to:
  - Pre-wired dimming and switching cabinets.
  - Multi-zone, multi-scene preset controllers.
  - A/V, BMS, motorized shade, and timeclock interface circuitry.
  - Partitioned room control.
  - Motorized shade and screen control.
  - Remote control stations.
  - Emergency "Full-On" components and circuitry.
  - Laptop computer graphical user interface & setup.
  - Handheld lighting programmer.
3. Submit project-specific riser and wiring diagrams indicating and specifying field wiring and connections required for the project.

1.04 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers shall be considered, subject to its acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Design and performance criteria are based on products manufactured by Lutron Electronics Company, Grafik Eye 4000 Series GP dimmer panelboards and XP relay panelboards as indicated on the drawings.

1.05 SHOP DRAWINGS

1. Submit manufacturer's standard catalog data including application, wiring, and installation information on components and sub-systems.
2. Provide test data and/or samples as required to demonstrate conformance with PART 2 of this specification.
3. Submit the following shop drawings:  
  
Control equipment physical and performance data.  
Zone and module schedules.  
Dimmer and relay panels.  
Relay equipment and schedules (shade controls).  
Remote control stations, engraving, and finishes.  
Wiring and installation diagrams and instructions.
4. Submit the following samples:  
  
Preset System Control coverplate.  
Wallbox coverplate.

1.06 QUALITY ASSURANCE

1. Manufacturer shall have a minimum of 10 years continuous experience in manufacturing architectural lighting control products.
2. Devices shall be U.L. and CSA Listed specifically for the required loads (i.e., Incandescent, fluorescent, magnetic low voltage transformer). Manufacturer shall provide file card upon request. Universal-type dimmers shall not be acceptable.



1.07 ACCEPTABLE MANUFACTURERS

1. Lutron Electronics Co., Inc., Grafik Eye 4000 Series, or pre-approved equal by Electronic Theater Controls (ETC) or Strand.
2. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for devices that meet or exceed the specifications included herein.
3. Equipment described here are products of Lutron Electronics Company, to set a standard of quality and performance. Products of the other manufacturer will be considered, subject to the standards of quality and system design intent described herein and on the drawings.

PART 2 - PRODUCTS

2.01 INTEGRAL DIMMING AND SWITCHING

1. Preset dimming control shall be capable of operating at rated capacity without adversely affecting design lifetime and shall mount individually in standard 2, 3, or 4 gang U.S. switchboxes.
2. Preset dimming control shall operate in an ambient temperature range of 0°C (32°F) to 40°C (104°F).
3. Preset dimming control shall meet IEC 801-2, tested to withstand 15 kV electrostatic discharge without damage or loss of memory, ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage, and U.L. 20 limited short circuit test requirement for snap switches.
4. Preset dimming control shall be voltage regulated so that a  $\pm 10\%$  variation in line voltage shall cause no more than a  $\pm 5\%$  variation in load voltage when dimmer is operating at 40V (5% light output).
5. Preset dimming control shall utilize an LC filtering network to minimize interference with properly installed radio, audio, and video equipment.
6. Preset dimming control shall operate (dim or non-dim) the following sources/load type with a smooth and continuous Square Law dimming curve. Universal type dimmers shall not be acceptable.
7. Incandescent, Tungsten and Magnetic Low Voltage Transformer Dimming
  - a. Dimmer shall contain circuitry specifically designed to control and provide a symmetrical AC waveform to the input of magnetic low voltage transformers.

- b. Dimmer shall not cause a magnetic low voltage transformer to operate above the transformer's rated operating current and temperature.
  - c. Dimmer shall contain circuitry to control dioded lamps.
8. Fluorescent Electronic Dimming Ballasts
- a. Dimmer shall be rated to control T-12, T-12 high output, T-8, T-5 and T-5 high output lamps at 120 VAC with the use of an interface. Lamps on the same circuit must have the same current rating (i.e., T-8), but may be different lengths (i.e., 3', 4').
  - b. Ballasts for fluorescent fixtures shall be Lutron Hi-lume "FDB" series for 1% dimming, Lutron "Compact SE" series for 5% dimming, and Lutron "ECO-10" series for 10% dimming. See lighting designer's fixture schedule, sections 265000 and 265510, and/or dimming schedule for specific ballast model numbers.
9. The dimming performance shall be as follows:
- a. Dimming range down to 1% light output (5% for compact T-5 twin tube lamps).
  - b. One- and two-lamp ballasts track evenly, with no perceptible difference in light levels for the same type lamps.
  - c. Different lamp lengths on the same circuit shall track evenly, with no perceptible difference in light levels for the same type lamps.
  - d. Ballasts shall be inaudible with no apparent humming or buzzing at any point in the dimming range.
  - e. Ballasts shall have: a power factor greater than .95, ballast factor equal to .93, total harmonic distortion less than 10%, and lamp current crest factor less than or equal to 1.6.
  - f. Ballasts shall be inaudible in a 27dB ambient throughout the dimming range.
  - g. Ballasts shall be capable of striking lamps at any light level without first flashing to full light.
  - h. Ballasts must comply with FCC Part 18 regulations and shall not interfere with other properly installed electrical equipment.
  - i. Ballasts shall have a minimum starting temperature of 10°C and shall be free of polychlorinated biphenyls (PCB's).

2.02 DIMMING AND RELAY SWITCHING PANELS

1. Panels shall be wall mounted NEMA grade, constructed of sheet steel plates not less than #16 U.S. gauge. Contractor shall reinforce wall as required for wall-mounted panels and provide vibration isolation as recommended by the manufacturer.
2. Panels shall be completely pre-wired by the manufacturer. The contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the contractor shall be permitted.
3. Unless otherwise indicated, panels shall contain branch circuit protection for each dimming module. Branch circuit breakers shall have the following performance characteristics:
  - a. U.L. listed under U.L. 489 as a molded case circuit breaker for use on lighting circuits.
  - b. Contain a visual trip indicator and shall be rated at 65,000 AIC (120/208/240V) or 65,000 AIC (277/480V), unless otherwise approved based on results of the short circuit study (Section 260000). Note: Dimming panel short circuit rating shall be as indicated on the drawings. Coordinated with short circuit and coordination study.
  - c. Circuit breakers shall be rated 20 amperes.
  - d. Thermal-magnetic in construction for both overload and dead short protection. The use of fully magnetic breakers shall not be acceptable, even when used in conjunction with individual dimmer thermal cut-outs.
  - e. Switching duty (SWD) rated so that the loads can be switched off via the breakers.
4. Panels shall be shipped with each dimmer and relay in a BYPASS position via a jumper bar inserted between the input and load terminals. These jumpers shall carry the complete load current and shall be reusable at any time.
5. Panels shall be cooled via free-convection, unaided by fans, and capable of continuous operation in an ambient temperature range of 0°C (32°F) to 40°C (104°F). To provide the utmost in reliability, panels that normally use cooling fans must have the panel capacity derated by 50%. A lesser derating will be allowed providing that the manufacturer can substantiate via an independent test laboratory that with no fans operating, and at full-rated dimmer capacity, the temperatures of the main semiconductors are at least 20°C below maximum temperature rating and the temperatures of the filter chokes are within the maximum allowable temperatures of these components at an ambient temperature of 40°C.

6. Dimming panels shall have the following additional performance characteristics:
  - a. Designed to prevent any foreign objects from coming in contact with any part of the panel that would be at an elevated temperature, such as the dimmer extrusions or heat fins.
  - b. Designed to provide airflow across the heat sink areas and through the dimmer chassis. Panel sections that provide airflow only across heat sinks shall not be mounted one above another in order to allow for adequate heat dissipation.
  - c. Panel shall provide capability to electronically assign each circuit to any zone in the dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable.
  - d. Multiple panels shall be capable of operating in one system, up to a maximum of 32 panels and 768 dimmers.
  
7. Relay panels shall have the following additional performance characteristics:
  - a. Panel shall provide capability to electronically assign each circuit to any zone in the switching and dimming system. Panels using mechanical switches, rewiring, or EPROMS shall not be acceptable.
  - b. Panel shall accommodate up to 48 switch legs with or without branch circuit breakers as indicated on drawings.
  - c. Multiple panels shall be capable of operating in one system, up to a maximum of 32 panels and 768 dimmers.

### 2.03 EMERGENCY "FULL-ON" SYSTEM ELECTRONICS

1. Circuits listed as emergency shall be connected to their respective circuit breakers in the emergency dimming panels (EDP's) as shown on the drawings. They shall be controlled simultaneously with other lighting circuits within that control zone during the presence of normal utility power.
2. Upon loss of normal power and the subsequent presence of emergency power, the circuits listed as emergency shall immediately go to a full-on condition. Local control stations shall be inoperable during this period.
3. Once normal power is restored, lighting zones shall revert back to their status prior to the emergency condition (restoration to some other "default" level is not acceptable).
4. Upon fire alarm condition or signal from the BMS circuits shall immediately go to a full-on condition. Once the fire alarm or BMS signal is removed, lighting zones shall revert back to their status prior to the signal condition (restoration to some other "default" level is not acceptable). See 2.06(e) "Accessory Control Options".

2.04 DIMMING MODULES

1. Quantities of dimmer modules shall be provided to control each type of load shown on the load schedule and/or the drawings.
2. Dimmers shall be voltage regulated so that a nominal change in line voltage shall not cause a perceptible change in output voltage.
3. Under full-load conditions in a 40°C environment, silicon thyristors shall operate at a minimum 20°C safety margin below the component temperature rating. The maximum allowable asymmetry in the load waveform shall be  $\pm 1$  VDC.
4. Each dimmer shall incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps the lights up to the appropriate levels within 0.5 seconds.
5. Once installed as part of a complete system, the silicon thyristors used to control the power furnished to the loads shall be both designed and tested to withstand surges, without impairment to performance, of 6000V, 3000A (equivalent to a near lightning strike) as specified by ANSI/IEEE std. C62.41. Upon request the manufacturer shall provide a means to demonstrate conformance to this specification using the appropriate surge-generation equipment.
6. Filtering shall be provided in each dimmer so that current rise time shall be at least 350 $\mu$ sec at 50% rated dimmer capacity as measured from 10-90% of the load current waveform at a 90° conduction angle, and at no point rise faster than 30mA/ $\mu$ sec. Manufacturers should note that additional filters may be required to meet this specification. These filters need not be integral to the dimming module, but shall be integral to the dimming cabinet.
7. Dimmer output voltage shall be a minimum 95% of input voltage at maximum intensity setting.
8. Dimmers shall operate the following sources/load types with a smooth continuous Square Law dimming curve. Dimmers shall also be capable of operating these sources on a non-dim basis. Universal-type dimmers that do not adjust the dimming curve shall not be acceptable.
9. Incandescent, Tungsten and Magnetic Low Voltage Transformer Dimming
  - a. Dimmers shall not cause a magnetic low voltage transformer to operate above the transformer's rated operating current and temperature under any load condition on the transformer secondary.
  - b. Dimmers shall contain circuitry to control dioded lamps.
10. Electronic Low Voltage Transformer Dimming
  - a. No flicker or interaction shall occur at any point in the dimming range.

11. Fluorescent Electronic Dimming Ballasts
  - a. Dimmer shall be rated to control T-12, T-12 high output, T-8, and T-5 lamps. Lamps on the same circuit must have the same current rating (i.e., T-8), but may be different lengths (i.e., 3' and 4'). Ballasts for fluorescent fixtures shall be Lutron Hi-lume "FDB" series (1% min. dimming level) [\$60/ballast] or Lutron "Compact SE" series (5% minimum dimming level) [\$90/ballast] or Lutron "ECO-10" series (10% minimum dimming level) [\$90/ballast]. See fixture schedules for specific ballast model numbers.
  
12. Neon & Cold Cathode
  - a. Dimmer shall provide the ability to dim lamps down to 1% of full light output when used with normal (low) power factor transformers without flicker or striations.
  
13. Non-Dim Controls
  - a. Non-dim controls shall be rated to switch 16A of resistive, tungsten, inductive, or capacitive loads. Non-dim controls shall incorporate an air gap relay to open circuit when load is off.
  
14. Minimum light levels shall be user adjustable for each dimmer in order to compensate for different loading of each dimmer.
  
15. Maximum light levels shall be user adjustable for each dimmer to predetermine energy and potential lamp life savings.

#### 2.05 RELAY SWITCHING MODULES

1. Provide quantities of relays to control each type of load shown on the load schedule and/or the drawings.
  
2. Relay switching modules shall contain four switching mechanisms. Each switching module shall connect or disconnect up to 16 amperes continuous duty for the following load types: resistive (incandescent/tungsten), inductive (magnetic low voltage (MLV), electronic low voltage (ELV), neon/cold cathode, magnetic & electronic fluorescent lamp ballasts, high intensity discharge (HID); motor loads (1/3HP at 100-127 volts, 1/2HP at 220-347 volts). Relays rated only for resistive loads are not acceptable. Average rated life of relay shall be at least 1,000,000 cycles.

#### 2.06 CONTROL

1. General
  - a. Definitions: A "scene" or "preset" is a specific look or mood created by different lighting zones set at different intensities. A "zone" is one or more lighting circuits which are controlled together as a group.

- b. Preset dimming control shall provide power failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable, unless specifically noted elsewhere.
- c. Faceplate shall attach using no visible means of attachment. Faceplates shall have brushed metallic finish as selected by architect. Plastic faceplates shall not be acceptable.
- d. Wiring from dimming panel to preset dimming control and accessory controls shall be low voltage type Class 2 wiring, daisy-chain style, wire type and connections as recommended by panel manufacturer.
- e. Panel processor shall:
  - 1) Electronically assign each circuit to any zone in the system.
  - 2) Determine Normal/Emergency function of panel and set emergency lighting states.
  - 3) Operate each circuit in the system.
  - 4) Maintain switched outputs at current state (ON or OFF) in the event of control failure. Systems that fail to a set state (OFF or ON) during a control failure are not acceptable.
  - 5) React to changes from the control in no more than 20 milliseconds.

2. Four Scene Preset Control

- a. Where indicated on the drawings, control shall provide 4 preset lighting scenes and off for up to 8 control zones. Control shall be capable of storing an additional 12 preset lighting scenes. Up to 8 controls may be tied together for more than 8 zones. Controls shall incorporate built-in wide angle infrared receiver, providing control via a separate wireless remote control transmitter from up to 50 feet away. Preset shall be set via easy-to-use raise/lower switches, one raise and lower switch per zone. The intensity for each zone shall be indicated via an illuminated barograph, one barograph per zone. More than one zone may be proportionately raised or lowered at the same time.
- b. Additionally, one or more zones may be temporarily overridden without altering the scene values which are stored in memory. Lighting levels shall fade smoothly between scenes at time intervals of 0-59 seconds or 1 to 60 minutes. The fade time shall be separately selectable for each scene and shall be indicated by a digital display for the current scene.
- c. Pressing a scene select button will also light the corresponding scene LED and simultaneously begin changing the barograph levels to reflect the currently selected scene. In the event that a preset scene with a fade time greater than 5 seconds is initially selected from an OFF condition, the programmed fade time shall be temporarily overridden, unless otherwise noted, and the lights shall fade up to that scene over a five-second time span.

3. LCD Wallstation
  - a. The LCD wallstation shall access and display every area, scene and zone within the lighting control processor. The LCD wallstation shall allow the user to:
    - 1) View and modify the scene status of an area.
    - 2) Temporarily modify zone intensities in an area.
    - 3) View timeclock status for each area.
    - 4) Enable or disable timeclock for an area.
    - 5) Permanently modify zone intensities, delay times and fade times.
  
4. Handheld Programmer
  - a. The handheld programmer shall provide the ability to change intensity and fade time for each zone without the use of a personal computer (PC). Unit shall allow access to each area, scene and zone in the system including: current light level indication and adjustment. Include a 25' cord.
  
5. Laptop Computer
  - a. Provide a laptop personal computer for programming the centralized lighting control system including the following:
    - 1) Pre-loaded software: Windows operating system XP Professional, Lutron DesignIT software, Microsoft .NET Framework 1.1.
    - 2) CPU – Intel **Core Duo** L2400
    - 3) Memory – 3.0G RAM
    - 4) Display – Color TFT LCD
    - 5) Disk space – 5 GB
    - 6) Floppy drive – 3.5” 1.44 MB
    - 7) DVD/CD ROM drive – 16x
    - 8) Modem – 56K Baud PCMCIA
    - 9) Ethernet Port
  
6. Accessory Control Options
  - a. Provide the following controls for use with the preset control(s) as shown on the drawings:
    - 1) Two Scene Entrance Control(s) shall be capable of recalling Scene One plus Off.
    - 2) Four Scene Control(s) shall be capable of recalling any one of four scenes, master raise/lower and Off. Control shall provide access up to 16 scenes.
    - 3) Fine Tuning Control(s) shall allow the temporary override of a particular zone or zones from the preset light level.
    - 4) Special Function Control(s) shall provide the following functions:
  
  - b. Sequencing shall allow the user to set up and operate a sequence of 4 or 12 steps. A sequence shall be defined as a series of steps, while a step shall be defined as the recall of a scene. Each step interval is adjustable from 1 second to 60 minutes.



- c. Zone lockout shall allow temporary changes without altering the light levels preset for each scene.
- d. Scene lockout shall lockout the control, maintaining current scene and disabling buttons on the preset dimming control.
- e. Fade override shall set fade times to zero.
- f. Partitioned room interface ("room combiner control") shall combine functions of controls in adjacent rooms when partitions are open and provide separate room control when partitions are closed.
- g. Motorized shade and screen control: Provide momentary contact closures, activated by individual raise/lower switches on the dimmer control station, to provide opening and closing of motorized shades and raise/lower of projection screens. Coordinate control voltage and relay requirements with shade and screen manufacturers.
- h. Infrared control: Provide wireless remote control capable of recalling preset light levels that shall operate up to 50 feet within line of sight of receiver. Ceiling mounted receiver shall provide 360° reception range.
- i. Daylighting: Provide astronomic timeclock interface to determine the times during which direct sunlight is incident on the façade being controlled using a single interior photocell to control shade positions and intensity of lighting. Include manual override controls for both lights and shades.
- j. Equipment Interface(s), fire alarm, BMS, etc., shall allow access to preset dimming control(s) via isolated momentary/maintained dry contact closures. Where indicated on the drawings, each interface shall provide isolated maintained contact closures rated at 200mA at 30VDC for pilot light status feedback.

7. Control Interfaces

- a. Provide ability for the centralized lighting system controls to interface and communicate with the following:
  - 1) Contact closure: Interface with dry contact closures devices such as timeclock inputs, BMS, fire alarm system, security system, and occupancy sensors.
  - 2) RS232: Communicate via RS232 serial communication to a user supplied PC or digital audio visual equipment.
  - 3) BACnet: Communicate via BACnet IP or BACnet Ethernet from a user supplied 10BaseT Ethernet network.

- 4) LonWorks: Communicate via LonWorks FTT-10.
- 5) DMX512: Convert 32 control intensities to 32 continuous DMX512 outputs.
- 6) Daylighting: Automatically select light levels in response to ambient daylight via four thresholds for selection of light levels. Include photocell calibration, averaging for up to three photosensors.
- 7) Room assignor control panel(s): Accept up to 32 contact closure inputs including the following functions: scene selection, panic mode, occupancy response, sequencing, zone and scene lockouts, and partitioning. Include visual status.

## 2.07 DIMMING SYSTEM DESCRIPTIONS

### 1. General

- a. Dimming for the areas of work shall be accomplished by a series of systems which are controlled locally within the area(s) served and remotely from the area(s) shown - Refer to Lighting Design Documents.

### 2. Preset Scene Dimming Systems - Refer to Lighting Design Documents

## 2.08 QUALITY CONTROL

1. Components shall be inspected following U.S. military standard 105D or equivalent. Equipment shall be fully tested for proper operation prior to shipment from the factory.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

1. Equipment shall be installed utilizing manufacturer's shop drawings and in accordance with these specifications.
2. Surface-mounted dimmer panels shall be mounted on ¾-inch plywood backboard or ¾-inch galvanized steel channel secured to wall. Do not use plywood backboard in wet or damp locations. Provide galvanized steel channel to stand panels six inches off wall to allow routing conduit or cable behind panels.
3. The Electrical Contractor shall run separate neutrals for branch load circuits.
4. Where a dimming panel is indicated and upon completion of the installation and prior to removal of the bypass jumpers, the electrical contractor shall completely test line voltage power and low voltage control wiring for continuity and accuracy of connections. The

jumpers shall remain in place until loads have been fully tested and found to be free of miswires, short circuits, or other wiring defects.

5. Manufacturer shall provide access to qualified personnel able to address problems with the dimming system 24 hours per day, 365 days per year.
6. Manufacturer shall provide (4) sessions of 8 hours training sessions.

### 3.02 SYSTEM COMMISSIONING

1. Upon completion of the installation, the system shall be completely commissioned by a factory-trained engineer. The commissioning will be performed upon notification by the electrical contractor that the system installation is complete and that loads have been tested live for continuity and freedom from defects and that control wiring has been connected and checked for proper continuity. The electrical contractor shall provide both the manufacturer and the Architect with ten working days notice of the scheduled commissioning date.
2. New fluorescent lamps shall be seasoned for dimming applications by operating at full intensity for their first 100 hours. Leave lamps at full intensity for 100 continuous hours to achieve good dimming performance and normal lamp life.
3. Upon completion of the system check-out, the engineer shall demonstrate the operation of the system to appropriate owner's representatives.

### 3.03 WARRANTY AND WARRANTY SERVICE

1. Unless otherwise noted, Manufacturer shall provide a two year warranty on the complete system for systems with factory commissioning. Warranty shall cover 100% of the cost of the manufacturer's services and any replacement parts required over the first two years which are directly attributable to the manufacturer.
2. Manufacturer shall provide a two year warranty on the complete system for systems without factory commissioning. Warranty shall cover 100% of the cost of the manufacturer's services and any replacement parts required over the first year which are directly attributable to the manufacturer.
3. Warranty coverage shall begin from date of final system commissioning or three months from date of delivery, whichever is the earlier. Commissioning and warranty service shall be performed by a factory-trained engineer.

END OF SECTION

SECTION 26 22 00 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
2. See other Division 26 sections for requirements of switchboards, panelboards, and other electrical distribution equipment not included herein.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' catalog data for dry-type transformers, including the following information:
  - a. Rating, temperature rise, % impedance, sound levels, efficiencies, no-load losses and total losses.
  - b. Enclosure type and dimensions.
  - c. Tap ratings and quantities.
  - d. UL, ANSI, and NEMA compliance.
2. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

**PART 2 - PRODUCTS**

**2.01 DRY TYPE TRANSFORMERS**

1. Provide ventilated, dry type transformers with drip-proof openings, 3 phase delta primary, grounded wye secondary, aluminum or copper windings, U.L. listed and labeled, of the indicated KVA ratings and voltages.
2. Transformers shall comply with applicable UL, NEMA and ANSI standards for general purpose dry type transformers.
3. Transformer insulating materials shall exceed NEMA ST20 standards and shall have a 220°C component recognized insulation system.
4. Transformers shall comply with NEMA standard TP1 for optimum energy efficiency at 35% load. Transformers shall be labeled for EPA Energy Star program. Provide 150°C rise transformers for all transformers indicated on the drawings, unless specifically otherwise noted. Efficiencies shall be tested in accord with NEMA TP2, in minimums as follows:

Single Phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7%	15	97.0%
25	98.0%	30	97.5%
37.5	98.2%	45	97.7%
50	98.3%	75	98.0%
75	98.5%	112.5	98.2%
100	98.6%	150	98.3%
167	98.7%	225	98.5%
250	98.8%	300	98.6%
333	98.9%	500	98.7%
		750	98.8%

5. Transformers specifically designated on the drawings shall be Class 155 insulation minimum per UL 1561 and shall be designed for a maximum winding temperature rise of 80°C at rated load in a 40°C ambient. 80°C transformers shall comply with NEMA standard TP-1 and shall be designed for low energy losses at loads greater than 50% of nameplate rating. 80°C rise transformers shall have a continuous emergency overload capability of 30%. Provide 80°C rise transformers unless otherwise indicated on the drawings.
6. Where indicated on the drawings with a Harmonic Suppression rating, transformers shall be constructed, listed, and labeled to supply non-linear loads of the specified Transformer Based Harmonic Suppression System with Integral Transient Voltage Surge Suppression
7. Description  
 Harmonic suppression system shall consist of a three-phase, 3-wire primary, 3-phase 4-wire secondary, dry type transformer with a series connected neutral harmonic

suppression system, parallel connected transient voltage surge suppression and high frequency noise filter which are factory wired and enclosed in a NEMA 1 construction.

8. Transformer/ Harmonic Suppression System performance ratings shall be as follows based on 208/120-volt secondary.

MODEL	FULL LOAD kVA	RATING IN AMPS
HLTMP015	15	42
HLTMP030	30	83
HLTMP045	45	125
HLTMP075	75	208
HLTMP112	112.5	311

9. Dry type distribution transformer shall have the following characteristics and features:

- |    |                          |                                 |
|----|--------------------------|---------------------------------|
| a. | kVA rating               | As indicated on drawings        |
| b. | Input voltage            | 480 volt delta                  |
| c. | Output voltage           | 208 volt, 3-phase, 4 wire, wye  |
| d. | Insulation class         | 220 degree C                    |
| e. | Temperature class        | 115 degree C rise               |
| f. | Mechanical               | Core and coil                   |
| g. | Winding material         | Copper                          |
| h. | Electrostatic shield     | Yes                             |
| i. | Taps                     | 2 x 2.5% FCAN and 2 x 2.5% FCBN |
| j. | Enclosure                | Type 1                          |
| k. | Energy Efficiency rating | Meets TP-1-1996 -- Energy Star  |

10. Transient voltage surge protector and high frequency noise filtering devices shall have the following characteristics:

- |    |   |  |
|----|---|--|
| a. | Connection means                              | Parallel   |
| b. | Single pulse surge current capacity per phase | 160,000 A or greater   |
| c. | Capacity per mode                             | L-N 80,000 A or greater<br>L-G 80,000 A or greater<br>L-L 80,000 A or greater<br>N-G 80,000 A or greater |
| d. | EMI/RFI Noise attenuation                     | 100kHz – 100Mhz  |

11. Provide primary winding voltage taps, minimum, as follows:

- |    |   |
|----|---|
| a. | 15 KVA and below: four 2 1/2%, two FCAN and two FCBN. |
| b. | 30 KVA and above: six 2 1/2%, two FCAN and four FCBN. |

12. Core and coil assemblies shall be mounted on vibration isolators and visibly grounded by means of a flexible grounding conductor to prevent noise transmission to case and building. There shall be no metal-to-metal contact between the core and coil and the enclosure except for the flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices shall not be acceptable. Sound levels shall be certified by the manufacturer not to exceed the following values:

- a. 15 - 50 KVA < 45 dB
  - b. 51 - 150 KVA < 50 dB
  - c. 151 - 300 KVA < 55 dB
  - d. 301 - 500 KVA < 60 dB
  - e. 501 - 700 KVA < 62 dB
  - f. 701 - 1000 KVA < 64 dB
  - g. 1001 - 1500 KVA < 65 dB
  - h. 1501 - 2000 KVA < 66 dB
13. Units up to and including 45 KVA shall be suitable for either wall or trapeze/ceiling mounting.
14. Units up to and including 112.5 KVA shall be suitable for trapeze/ceiling mounting.

## 2.02 ACCEPTABLE MANUFACTURERS

1. Subject to compliance with requirements, provide energy saving WatchDog transformers manufactured by or equivalent by one of the following:
  - a. Square D
  - b. Cutler-Hammer Westinghouse
  - c. Liebert Corporation
2. Subject to compliance with requirements as described in 2.1 above of this specification, provide harmonic mitigation (HM) transformers as manufactured by Harmonics limited or pre-approved equal.

## PART 3 - EXECUTION

### 3.01 GENERAL

1. See Section 260500 BASIC MATERIALS.

### 3.02 INSTALLATION - TRANSFORMERS

1. Make primary and secondary connections with minimum 24" of flexible steel conduit to minimize vibration transmission.
2. Bond grounded conductor to the transformer case, to the nearest available interior metal water piping, to nearest grounded building steel, and to other metal piping in accordance with requirements of NEC Article 250. Size conductors per NEC, but use no smaller than No. 4 AWG copper.
3. For K-Factor rated transformers, connect with secondary neutral conductors rated 200% of rated secondary amperes.

4. Adjust tap connections as necessary to achieve a no-load secondary voltage of 100-105% of nominal.
5. Provide vibration & noise control and seismic restraints. Refer to Section 260548.
6. Provide a concrete housekeeping pad, minimum 4-inches thick, for floor-mounted transformers.

3.03 FIELD QUALITY CONTROL

1. Measure primary and secondary voltages and make appropriate tap adjustments.

3.04 WARRANTIES

1. Manufacturers' Warranties

- a. The manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:
  - 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
  - 2) For a period of 18 months from date of acceptance by the Owner or twenty four months from date of shipment, the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, and labor for parts replacement are the responsibility of the installing contractor.
  - 3) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
- b. The final acceptance of the equipment will be made by the commissioning agent after the manufacturer has adjusted his equipment, tested the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project. Refer to the phasing documents for additional information and criteria.

END OF SECTION



SECTION 26 22 12 - COMPUTER-GRADE ISOLATION TRANSFORMERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. This section covers the specification of a three-phase Harmonic Suppression System as manufactured by Harmonics Limited, Brookfield, CT or pre-approved equal, for phase to neutral connected loads with integral dry type transformer and transient voltage surge suppression with high frequency noise filtering. Refer To specification 260000 2.02 E.
2. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
3. See other Division 26 sections for requirements of switchboards, panelboards, and other electrical distribution equipment not included herein.

1.03 SCOPE

1. Provide labor, materials, equipment, services and transportation necessary for complete and operational systems as shown on the Contract Drawings and specified herein, including, but not limited to, the following:
  - a. Transformer based Harmonic Suppression System (HSS)
  - b. Integral transient voltage surge suppressor (TVSS)
  - c. Grounding of transformer / Harmonic Suppression System / TVSS devices
  - d. Start-up of transformer, HSS, and TVSS
2. It is the intent of this section to provide low frequency harmonic suppression, transient voltage surge suppression, and high frequency noise filtering integral to a three phase, 3-wire primary, 3-phase, 4-wire secondary, dry type distribution transformer with features, ratings and options as specified herein:
3. HSS shall be a passive device to be installed at the secondary of a wye connected distribution transformer at a voltage of 208/120 and at a frequency of 60Hz. The HSS shall reduce the 3rd harmonic current flowing in the phase wires and the neutral wire from the transformer to the furthest outlet.

1.04 SUBMITTALS

1. Submit manufacturer's technical product data and performance specifications for the following components:
  - a. Transformer
  - b. Harmonic Suppression System
  - c. Transient Voltage Surge Suppressor
  - d. High Frequency Noise Filtering Components
  
2. Shop drawings shall include the following information:
  - a. Product specification sheets
  - b. Product dimensional data
  - c. Delivery, installation and testing information
  - d. Wiring and interconnection diagrams
  - e. Schedule of proposed shut downs if required
  - f. TVSS per phase and per mode ratings
  - g. UL, ANSI, and NEMA compliances.
  - h. Noise attenuation.
  - i. Harmonic current, crest factor, THD and RMS neutral current reduction.
  - j. Transient voltage suppression system ratings.
  
3. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

1.05 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to all state and local codes and laws.
  
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers may be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
  
3. All materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.06 PERFORMANCE

1. The HSS shall be totally passive in operation and shall not contain any electronic switching devices such as transistors, SCRs, etc.
  
2. The HSS shall be entirely self-contained in its own enclosure and shall not require any external enclosures.

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**COMPUTER-GRADE ISOLATION TRANSFORMERS**  
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3. The HSS shall consist of a single unit per transformer in a three-phase wye connected power system.
4. The HSS will be operative to remove harmonic currents on all three phase wires and the neutral wire of a power system loaded with single-phase non-linear loads connected phase to neutral.
5. The HSS shall be protected by the same fuses or circuit breakers that protect the phase wires for the transformer and shall not require any separate fusing for protection.
6. The HSS shall be capable of handling the full rated load of the transformer, and shall not require resizing as the transformer is loaded to its full capacity with non-linear loads.
7. The HSS shall block the flow of harmonic current of the frequency, 3rd harmonic of the fundamental (180Hz in the case of a 60Hz fundamental).
8. The HSS shall reduce 3rd harmonic current flow, measured at the secondary of the transformer, in each of the three phase wires from the transformer out to the furthest outlet.
9. The HSS shall reduce rms current flow, measured at the secondary of the transformer, in each of the three phase wires from the transformer out to the furthest outlet.
10. The HSS shall reduce 3rd harmonic current flow, measured at the secondary of the transformer, in the neutral wire from the transformer out to the furthest outlet.
11. The HSS shall reduce rms current flow, measured at the secondary of the transformer, in the neutral wire from the transformer out to the furthest outlet.
12. The reduction of harmonic currents in the phase wires and neutral shall result in increased system capacity to power useful loads.
13. In the event that each circuit consists of a phase wire and an individual neutral wire to each load, the HSS shall reduce 3rd harmonic current flow in every neutral wire in the entire distribution system, from the secondary of the transformer out to the furthest load.

1.07 SEQUENCE / SCHEDULE

1. All proposed interruptions of existing electrical services to critical loads shall be reviewed and approved by the Owner's representative.
2. Coordinate scheduled interruptions of electrical service with all concerned parties prior to beginning work.

1.08 WARRANTY

1. Unless otherwise specified, all equipment specified herein is warranted to be free of defects in materials and workmanship under normal use and service for a period of five years from the date of purchase.

**PART 2 - PRODUCTS**

**2.01 Transformer Based Harmonic Suppression System with Integral Transient Voltage Surge Suppression**

1. Description
2. Harmonic suppression system shall consist of a three-phase, 3-wire primary, 3-phase 4-wire secondary, dry type transformer with a series connected neutral harmonic suppression system, parallel connected transient voltage surge suppression and high frequency noise filter which are factory wired and enclosed in a NEMA 1 construction.
3. Transformer/ Harmonic Suppression System performance ratings shall be as follows based on 208/120-volt secondary.

MODEL	FULL LOAD kVA	RATING IN AMPS
HLTMP015	15	42
HLTMP030	30	83
HLTMP045	45	125
HLTMP075	75	208
HLTMP112	112.5	311

4. Dry type distribution transformer shall have the following characteristics and features:
  - a. kVA rating As indicated on drawings
  - b. Input voltage 480 volt delta
  - c. Output voltage 208 volt, 3-phase, 4 wire, wye
  - d. Insulation class 220 degree C
  - e. Temperature class 115 degree C rise
  - f. Mechanical Core and coil
  - g. Winding material Copper
  - h. Electrostatic shield Yes
  - i. Taps 2 x 2.5% FCAN and 2 x 2.5% FCBN
  - j. Enclosure Type 1
  - k. Energy Efficiency rating Meets TP-1-1996 -- Energy Star
5. Transient voltage surge protector and high frequency noise filtering devices shall have the following characteristics:
  - a. Connection means Parallel
  - b. Single pulse surge current capacity per phase 160,000 A or greater
  - c. Capacity per mode L-N 80,000 A or greater  
L-G 80,000 A or greater  
L-L 80,000 A or greater  
N-G 80,000 A or greater
  - d. EMI/RFI Noise attenuation 100kHz – 100Mhz

2.02 ACCEPTABLE MANUFACTURERS

1. Subject to compliance with requirements, provide computer-grade isolation transformers manufactured by one of the following:
  - a. Harmonics limited
  - b. Liebert Corporation
  - c. Current Technology

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 BASIC MATERIALS.

3.02 INSTALLATION - TRANSFORMERS

1. Provide secondary connections with 12"-24" of flexible steel conduit, to minimize vibration transmission to the building structure.
2. Bond grounded conductor to the transformer case, to the nearest available interior metal water piping, to nearest grounded building steel, and to other metal piping in accordance with requirements of NEC Article 250. Size conductors per NEC, but use no smaller than No. 4 AWG copper. Provide single-point ground per Section 260500 and as indicated on drawings.
3. Connect with secondary neutral conductors rated 200% of rated secondary amperes.
4. Adjust tap connections as necessary to achieve a no-load secondary voltage of 100-105% of nominal.
5. Provide vibration & noise control and seismic restraints. Refer to Section 260548.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this Section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this Section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this Section in accordance with the requirements of Section 260000 General Provisions, Section 260050 Removals and Section 260500 Basic Materials and Section 262700 Electric Service.
2. See other Division 26 Sections for requirements of panelboards and other electrical distribution equipment not included herein.
3. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.
4. Provide 18 month full equipment warranty, the contractor and manufacturer shall furnish and provide parts and labor for equipment replacement.

1.04 SUBMITTALS

1. Submit manufacturers' catalog data for switchboards and components, including construction details and device specifications.

2. Submit project-specific shop drawings including the following:
  - a. Switchboard tag number and ratings.
  - b. Dimensioned floor plan and elevation views.
  - c. One-line diagram showing main and feeder devices.
  - d. Description of ground fault protection system.
  - e. Bus materials and ratings.
  - f. Lug sizes, types and locations.
  - g. Wiring diagrams of control and metering components, where applicable.
  - h. Details of utility and other auxiliary compartments, including top/bottom pullbox sections.
  - i. Installation instructions and requirements.
  - j. Description of meters, metering equipment and software.
  - k. Surge protection devices.
3. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

## PART 2 - PRODUCTS

### 2.01 SWITCHBOARDS

1. General Construction
  - a. Furnish and install a dead front, completely metal enclosed, self-supporting switchboard structure, independent of wall supports for equipment rated 1200 amperes and larger and as indicated on the drawings. Voltage and ampere ratings shall be as indicated on the drawings. Switchboards shall consist of the required number of vertical sections bolted together to form one rigid structure. The sides and rear shall be covered with removable screw-on plates. Edges of front cover panels shall be formed. Enclosures shall be NEMA 1 indoor construction except as noted on drawings and specified below:
  - b. Equipment shall comply with the latest applicable standards of NEMA PB2, UL 891 and NEC 408. Where switchboards are used as service entrance equipment, they shall comply with NEC and UL requirements for service entrance, and a UL service entrance label shall be provided.
  - c. Small wiring, fuse blocks, and terminal blocks within the switchboard shall be furnished as required. Groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Fuse and terminal blocks shall be readily accessible behind front access doors or covers, insulated or isolated from power bus bars and terminations.

- d. Switchboards shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the 4" high concrete housekeeping pads without the use of floor sills.
  - e. Furnish cable pull sections and top cable pull boxes as required, complete with cable tie down supports.
  - f. Switchboard components and cabling shall be front-accessible, and structures shall be rear-aligned, suitable for mounting against a wall, except that main device sections rated 2500 amperes or more shall be provided with side or rear access as recommended by the manufacturer.
  - g. Wiring terminals for switchboards rated less than 100,000 amperes short circuit current shall be pressure type lugs. Switchboards rated 100,000 amperes short circuit current and greater shall be provided with compression type lugs.
  - h. Units indicated as "Space" shall have necessary provisions including bus for future installation of a switch or breaker. Where the manufacturer's standard arrangements provide additional blank spaces, such spaces shall also have provisions for future devices.
2. Bussing
- a. Bus bars shall be silver-plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to UL and NEMA standards at rated ampacity. Provide full height vertical bus for distribution sections. Provide full capacity neutral bus in each switchboard. Include provisions for future bus extensions and additional switchboard sections.
  - b. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. Ground bus cross-sectional area shall be minimum 25% of the main bus.
  - c. Hardware used on bus bars shall be high-tensile strength and plated. Terminals shall be of the anti-turn solderless type suitable for copper or aluminum cable of sizes indicated, with 75°C insulation. Provide necessary bus splice hardware for field installation at shipping splits.
3. Circuit Breakers – Refer to section 260500.
- a. Where so indicated, provide circuit breakers with electric trip mechanisms, trip indication lights, trip test switches, and fused control power source. If required, provide a switchboard-mounted portable power pack for each switchboard to power up the trip unit to set or adjust trip set points when the breaker is not powered up.
4. Current-Sensing, Phase-Failure Relays: Provide solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase



reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage. Provide adjustable response delay.

5. Short-Circuit Ratings
  - a. Switchboards and devices shall be fully rated for the short-circuit currents indicated, and shall be so labeled. Series rating of main and feeder devices will not be accepted.
6. Utility Compartments
  - a. Where applicable, provide suitable compartments complete with bus work and supports for the installation of utility company metering transformers. See Section 262700 Electric Service for additional information.

## 2.02 SPD – SURGE PROTECTION DEVICES

1. Provide surge suppression devices internally mounted where indicated on the drawings. Equipment shall be manufactured by a single manufacturer and listed to the following standards, certified by an independent third party National Regulatory Testing Laboratory (NRTL) so as to operate as a system when more than one device is installed:
  - a. UL 1449, 3rd Edition updates effective September 29, 2009 “Surge Protective Devices”.
  - b. UL 1283 “Electromagnetic Interference Filters”.
  - c. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
  - d. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
  - e. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
  - f. National Electrical Code: Article 285.
  - g. SPD shall be UL labeled with 20kA nominal rating (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
2. SPD manufacturer shall have at least five (5) years experience in manufacturing surge protection devices and shall be ISO 9001 or 9002 certified.
3. SPD shall be factory installed. Surge protection devices shall be connected on the load side of utility metering compartment and shall comply with local utility requirements.
4. SPD shall provide Standard 7 Mode Protection paths for modes of protection as follows:
  - a. Wye systems: Normal mode suppression line-to-line, line-to-neutral, common mode suppression line-to-ground and neutral-to-ground.
  - b. Delta and impedance grounded wye systems: Line-to-line and line-to-ground.

5. Submittals shall include information describing each unit and as a minimum establish compliance with the following criteria:

a. UL listed and labeled as Type 1 intended for Type 1 or Type 2 applications as follows:

- 1) Service entrance: 300 kA per phase and 200 kA short circuit current rating (SCCR).
- 2) Distribution: 100 kA per phase and 200 kA short circuit current rating (SCCR).
- 3) Branch: 100 kA per phase and 65 kA short circuit current rating (SCCR).

b. Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200	1200V	2000V	320V

V

c. Maximum Continuous Operating Voltage (MCOV):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
208Y/120	25%	150V
480Y/277	15%	320V

- d. Suppression components shall be heavy duty metal oxide varistors and shall be field replaceable module(s) (service entrance only).
- e. Audible noise: 35db or less @ 3 feet from unit.
- f. Response time less than or equal to ½ nanosecond.
- g. UL 1283 listed EMI/RFI filter with noise attenuation: -50dB or greater at 100 kHz.
- h. Fusing: 200 kA symmetrical fault current interrupting capacity @ 600V.
- i. Phase and operational status indicator LED indicator lights for power and protection status.
- j. Surge counter (service entrance only).
- k. Integral circuit breaker or fused disconnect switch (service entrance only).
- l. Dual set of Form C dry contacts for remote monitoring.
- m. Audible alarm & alarm disable.

2.03 CUSTOMER METERING SYSTEM

1. Where indicated on the drawings, provide main, sub-main and feeder circuits with microprocessor-based digital power meters as herein specified. Analog meters are not acceptable.

2. Meters shall be completely factory-installed, wired, and calibrated, and shall include the necessary current transformers, and fused potential or control power transformers or bus taps, to provide the specified functions. Customer metering shall be connected on the load side of utility metering compartment and shall comply with local utility requirements.
3. Meters shall be mounted either with the associated breaker, or group-mounted in an adjacent vertical section of the switchboard, clearly labeled with the associated breaker I.D., subject to switchboard manufacturer's space and arrangement requirements.
4. Meters shall continuously monitor the following parameters, with keypad selection of the display:
  - a. Phase & neutral currents (each phase, up to 125% circuit amperes).
  - b. Phase-neutral & Phase-phase voltages.
  - c. VI unbalance.
  - d. KW and KVA demand (adjustable interval).
  - e. Demand: Amperes, KW and KVA.
  - f. KWH.
  - g. Hz: Watts, VAR, VA.
  - h. Watt-hour, VAR-hour, Watt cost.
  - i. Power factor.
  - j. Harmonic analysis through 63<sup>rd</sup> with THD and TIF.
  - k. Waveform capture.
  - l. Data logger: 98,000 events minimum.
  - m. Voltage disturbance recorder (VDR) – 500 events minimum.
5. Meters shall be auto-ranging for each parameter. Displayed values shall be actual values, requiring no multiplying factors; minimum 0.2% accuracy.
6. Each meter shall contain integral RS-485 and RS-232 serial data communications ports with ModBus and DNP 3.0 protocol for linking to a remote energy-monitor PC. Include Ethernet connectivity via Multinet or approved equal communications module. Communications and monitoring software package shall be provided by the meter manufacturer, shall be Windows (TM) based, and shall be able to continuously monitor data from up to 128 compatible devices. The data link shall be connected to, and the software loaded into, the BMS computer specified under another Division. Coordinate requirements between manufacturers.
7. Metering, software and accessories shall be Eaton Cutler-Hammer IQ 260, General Electric Multilin Power Quality Meter PQM II, Square D PowerLogic ION7550, Electro Industries/GaugeTech Nexus 1272 or approved equal by Power Measurement Limited.

2.04 ACCEPTABLE MANUFACTURERS

1. Subject to compliance with requirements, provide switchboards and components manufactured by one of the following:
  - a. Square D Company
  - b. Cutler-Hammer
  - c. Electrotech switchboard Co.

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260000 General Provisions and Section 260500 Basic Materials and Section 262700 Electric Service.

3.02 INSTALLATION

1. Install and assemble switchboards and components in strict accordance with manufacturer's instructions.
2. Field coordinate exact locations for bottom entry conduits, where applicable.
3. Drawings show schematic locations for switchboards with the contractor responsible for final field installation to Code standards and working clearances.
4. Clearly label the exterior of each switchboard with I.D. number from drawings, system voltage, and ampere rating of bussing and main protective device / MLO, and rating/Class of fuses on engraved nameplates.
5. Surge protection remote alarm: Provide for remote alarm monitoring connections. Provide raceway and 3#14 AWG conductors from surge protection device dry contacts to a junction box located adjacent to the switchboard including empty conduit from junction box to BMS. Final connection of SPD alarm contacts is provided under Division 23 and shall not require access to switchboard or de-energizing of switchboard.
6. Provide configuration and in-service testing of the Customer Metering System/EPMS by a factory authorized service representative for complete verification of the system. Include Owner's personnel training consisting of programming, startup, shutdown, troubleshooting, servicing and preventive maintenance of metering system.

3.03 FIELD ACCEPTANCE TESTING

1. After switchboard installation and assembly, but prior to energizing, the contractor shall provide the services of factory-authorized field service technicians to inspect each assembly, perform factory-recommended tests and adjustments, and to calibrate and set solid-state trip units and digital meters to suit project requirements.
2. A signed field service report for each unit shall be submitted for record.
3. Coordinate metering software loading, setup, checkout, and demonstration with the BMS package. Verify correct performance.
4. Adjust circuit breaker trip and ground fault settings in accordance with the approved coordination study and equipment manufacturer's recommendations.
5. Performance test the ground fault system in accordance with the requirements of NEC 230-95c.
6. Document and label the flash protection boundary and the incident energy in accordance with IEEE 1584, NEC and the approved short circuit, arc flash and overcurrent protection coordination study.
7. Where existing switchboards are replaced with new switchboards intercept the existing feeder circuits and extend to the new switchboards and connect to the new circuit breakers. Extended circuits shall use the same size and number of conductors as the existing circuits unless otherwise indicated on the drawings.
8. Provide (2) days of training and operation for equipment and metering software.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions, Section 260050 Removals and Section 260500 Basic Materials.
2. See other Division 26 sections for requirements of switchboards and other electrical distribution equipment not included herein.
3. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.
4. Provide 18 month full equipment warranty, the contractor and manufacturer shall furnish and provide parts and labor for equipment replacement.

1.04 SUBMITTALS

1. Submit manufacturers' catalog data for panelboards, including enclosure details and device specifications.
2. Submit a schedule for each panelboard, including the following information:
  - a. Panelboard tag number and ratings.
  - b. Enclosure type and dimensions.
  - c. Types and quantities of main and branch devices.

- d. Main lug sizes and locations.
  - e. Accessories and options furnished.
  - f. Bus materials.
  - g. Surge protection devices.
3. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

## PART 2 - PRODUCTS

### 2.01 CIRCUIT BREAKER PANELBOARDS

- 1. General
  - a. Furnish and install approved panelboards of types and configurations indicated and specified herein.
  - b. Panelboards shall comply with the following industry standards:
    - 1) UL Standards
      - Panelboards - UL67
      - Cabinet & Boxes - UL50
      - Circuit Breakers - UL489
    - 2) National Electric Code Article 408
    - 3) NEMA Standard - PB 1
  - c. Panels identified for use as service entrance equipment shall be so labeled and equipped.
- 2. Interiors
  - a. Interiors shall be completely factory assembled. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling or tapping.
  - b. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated.
  - c. A manufacturer's nameplate shall be provided listing panel type and ratings.
  - d. Bus bar taps for panels with single pole branches shall be arranged for sequenced phasing of the branch circuit devices.
  - e. A copper ground bus shall be included in panels. An isolated ground bus shall be provided in panels as indicated on Contract drawings.

- f. Where "SPACE" is indicated on the schedules, it shall be fully equipped for future installation of the indicated device, with a blank cover over live parts.

3. Boxes

- a. Boxes shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with standards. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. Provide gutter barriers for panels requiring through-feed gutters.
- b. At least four interior mounting studs with adjustable nuts shall be provided.

4. Trim

- a. Switching device handles shall be accessible without exposure to any live parts. Doors shall have flush type cylinder lock and catch, except doors over 48 inches in height shall have auxiliary fasteners top and bottom of door in addition to the flush type cylinder lock and catch.
- b. Door hinges shall be concealed. Locks shall be keyed alike directory frame and card having a transparent cover shall be furnished with each door.
- c. Exterior and interior steel surfaces of the trim shall be properly cleaned, primed with a rust inhibiting phosphatized coating, and finished with a gray ANSI 61 paint. Trims for flush panels shall overlap the box for at least 3/4 inch all around. Surface trims shall have the same width and height as the box.
- d. Front trim shall be hinged "door within a door" construction consisting of an inner door, outer door and an outer frame. Inner door shall allow access to circuit breakers and the outer door shall allow access to circuit breaker terminations, wiring and gutter space without having to remove trim. Provide key operated latch(s) on each door with multiple latches as required by size of doors. The outer frame shall be secured to the enclosure box with course thread slotted machine screws. Toggles, clamps and cam-operated fasteners are not acceptable. Provide a centered, top mounted stud secured to the enclosure box to facilitate outer frame removal and installation.

5. Bus Bars and Connectors

- a. Main bus bars and branch connectors shall be silver plated copper, sized in accordance with UL standards to limit the temperature rise on any current carrying part.
- b. Panelboards shall utilize bolt-on breaker connections.
- c. Provide full capacity insulated neutral bus in each panelboard. Neutral bussing shall have a suitable lug for each outgoing circuit requiring a neutral connection.



- d. Provide sub-feed, feed-through and through-feed lugs as shown on drawings.
6. Circuit breakers
- a. Refer to Section 260500 in addition to the following.
  - b. One and two pole circuit breakers for lighting circuits shall be labeled for switching duty (SWD) and (HID), if used for switching high intensity discharge lighting.
  - c. Circuit breakers shall be full-size type: Half-size, twin or tandem breakers are not acceptable.
  - d. Circuit breakers feeding exit lights and emergency lighting shall be provided with handle locking devices. Where so indicated, provide circuit breakers with padlocking devices.
7. Short-Circuit Ratings
- 1. Panelboards and devices shall be fully rated for the short-circuit currents indicated, and shall be so labeled. Series rating of main and branch devices will not be accepted.
8. Panelboard circuit configurations and voltage, ampere, and short-circuit ratings shall be in accordance with the schedules on the drawings.
9. Panelboards shall be commercial or industrial grade. Residential grade load centers will not be accepted.
10. Lighting and appliance panelboards and power distribution panelboards up to and including 400 amperes shall be equivalent of Square D NQOD or NF series
11. Power distribution panelboards rated above 400 amperes shall be equivalent of Square D I-line type HCN, HCM, HCW, HCNM or HCWM-U or

2.02 SPD – SURGE PROTECTION DEVICES

- 1. Provide surge suppression devices internally mounted where indicated on the drawings. Equipment shall be manufactured by a single manufacturer and listed to the following standards, certified by an independent third party National Regulatory Testing Laboratory (NRTL) so as to operate as a system when more than one device is installed:
  - a. UL 1449, 3rd Edition updates effective September 29, 2009 “Surge Protective Devices”.
  - b. UL 1283 “Electromagnetic Interference Filters”.
  - c. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
  - d. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

- e. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
  - f. National Electrical Code: Article 285.
  - g. SPD shall be UL labeled with 20kA nominal rating (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
2. SPD manufacturer shall have at least five (5) years experience in manufacturing surge protection devices and shall be ISO 9001 or 9002 certified.
  3. SPD shall be factory installed. Surge protection devices shall be connected on the load side of utility metering compartment and shall comply with local utility requirements.
  4. SPD shall provide Standard 7 Mode Protection paths for modes of protection as follows:
    - a. Wye systems: Normal mode suppression line-to-line, line-to-neutral, common mode suppression line-to-ground and neutral-to-ground.
    - b. Delta and impedance grounded wye systems: Line-to-line and line-to-ground.
  5. Submittals shall include information describing each unit and as a minimum establish compliance with the following criteria:
    - a. UL listed and labeled as Type 1 intended for Type 1 or Type 2 applications as follows:
      - 1) Service entrance: 300 kA per phase and 200 kA short circuit current rating (SCCR).
      - 2) Distribution: 100 kA per phase and 200 kA short circuit current rating (SCCR).
      - 3) Branch: 100 kA per phase and 65 kA short circuit current rating (SCCR).
    - b. Voltage Protection Ratings shall not exceed the following:
 

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V
    - c. Maximum Continuous Operating Voltage (MCOV):
 

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
208Y/120	25%	150V
480Y/277	15%	320V
    - d. Suppression components shall be heavy duty metal oxide varistors and shall be field replaceable module(s) (service entrance only).
    - e. Audible noise: 35db or less @ 3 feet from unit.
    - f. Response time less than or equal to ½ nanosecond.
    - g. UL 1283 listed EMI/RFI filter with noise attenuation: -50dB or greater at 100 kHz.

- h. Fusing: 200 kA symmetrical fault current interrupting capacity @ 600V.
- i. Phase and operational status indicator LED indicator lights for power and protection status.
- j. Surge counter (service entrance only).
- k. Integral circuit breaker or fused disconnect switch (service entrance only).
- l. Dual set of Form C dry contacts for remote monitoring.
- m. Audible alarm & alarm disable.]

### 2.03 ACCEPTABLE MANUFACTURERS

- 1. Subject to compliance with requirements, provide panelboards manufactured by one of the following:
  - a. Square D Company
  - b. Cutler-Hammer
  - c. Electrotech switchboard Co.

## PART 3 - EXECUTION

### 3.01 GENERAL

- 1. See Section 260500 BASIC MATERIALS.

### 3.02 INSTALLATION - PANELBOARDS

- 1. Drawings show schematic locations for panelboards with the contractor responsible for final field installation to Code standards and working clearances.
- 2. Unless otherwise indicated, mount panelboards with top of enclosure 6'-6" above finished floor. Mount securely, per manufacturer's instructions, with top and sides level and plumb.
- 3. Surface-mounted panelboards shall be mounted on ¾-inch plywood backboard or ¾-inch galvanized steel channel secured to wall. Do not use plywood backboard in wet or damp locations. Provide galvanized steel channel to stand panelboards six inches off wall to allow routing conduit or cable behind panelboards.
- 4. Provide typewritten as-built circuit directory information for each panelboard, including load description and location.
- 5. Clearly label the exterior of each panelboard with I.D. number from drawings, system voltage, and ampere rating of panel bussing and main protective device/MLO, and rating/Class of fuses on engraved nameplates.
- 6. For flush-mounted panelboards, provide 3-1" EMT sleeves to ceiling cavity above and below (3 conduits up, 3 conduits down), capped, for future additional branch circuit wiring.
- 7. Install required interconnecting conduit and wiring for multi-section panelboards.

8. Provide insulated gutter tap assemblies with insulating cover; Burndy Type KPU-AC Polytap or Type UCU-AC Riser Tap or equal by O.Z. Gedney. Split-bolt and taped tap connections are not acceptable.
9. Document and label the flash protection boundary and the incident energy in accordance with IEEE 1584, NEC and the approved short circuit, arc flash and overcurrent protection coordination study.
10. Surge protection remote alarm: Provide for remote alarm monitoring connections. Provide raceway and 3#14 AWG conductors from surge protection device dry contacts to a junction box located adjacent to the switchboard including empty conduit from junction box to BMS. Final connection of SPD alarm contacts is provided under Division 23 and shall not require access to panelboard or de-energizing of panelboard.
11. Where existing panelboards are replaced with new panelboards intercept the existing branch circuits and extend to the new panelboards and connect to the new circuit breakers. Extended circuits shall use the same size and number of conductors as the existing circuits unless otherwise indicated on the drawings.
12. Provide (2) days of training and operation for equipment and metering software.

END OF SECTION

SECTION 26 25 00 - FEEDER AND PLUG-IN BUSWAY

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Busway shall be of the same manufacturer as the switchgear supplied for this project. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.
4. REFERENCES
  - a. NEMA AB 1 - Molded Case Circuit Breakers.
  - b. NEMA BU 1 - Busways.
  - c. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
  - d. NEMA KS 1 - Enclosed Switches.
  - e. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

1. Shop Drawings: Submit project-specific shop drawings and indicate ratings, dimensions and finishes. Include dimensioned layout diagram, installation details and locations of supports and fittings such as firestops and weatherseals. Include details of wall and floor penetrations.

2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

1. Square D I-Line Series.
2. General Electric Spectra Series.
3. Eaton – Cutler Hammer – POW-R-WAY Series

### 2.02 INDOOR BUSWAY

1. Plug-In Busway: NEMA BU1, 3 phase, 5 wire plug-in busway rated 480Y/277 volts, 60 Hz. Provide non-ventilated housing with plug-in openings on 24 inch (610 mm) centers each side, with hinged doors to protect opening where plug-in unit is not installed. Ampere ratings as indicated on Drawings.
2. Feeder Busway: NEMA BU1, 3 phase, 5 wire busway rated 480Y/277 volts, 60 Hz. Provide ventilated housing. Ampere ratings as indicated on Drawings.
3. Conductors: Copper bars, fully insulated except at joints. Provide full neutral. Provide insulated ground bus.
4. Joints: Provide single bolt type, with silver-plated contact surface for bus and splice plate.
5. Provide fittings in accordance with manufacturer's recommendations.
6. Finish: Baked gray enamel.

### 2.03 OUTDOOR BUSWAY

1. Outdoor Feeder Busway: NEMA BU1; 3 phase, 5 wire outdoor busway rated 480Y/277 volts, 60 Hz. Provide galvanized steel housing with sealed seams and drain holes with removable plugs. Ampere ratings as indicated on Drawings.
2. Conductors: Copper bars insulated with Class 130C material except at joints. Provide full neutral. Provide insulated ground bus.
3. Joints: Provide single bolt type, with silver-plated contact surface for bus and splice plate.
4. Provide fittings in accordance with manufacturer's recommendations.

5. Finish: Baked gray enamel.

#### 2.04 PLUG-IN UNITS

1. Feeder Units: Compatible with busway; enclosure with hinged door and externally operable handle for stick operation, lockable in OFF position; provide interlock to prevent opening front cover with switch in ON position. Provide insulated grounding stab.
2. Molded Case Thermal-Magnetic Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
3. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch. Fuse Clips: Designed to accommodate Class J fuses.
4. Combination Controllers: Combine controllers with motor circuit protector fusible switch disconnect in common enclosure, compatible with busway. Provide enclosure with hinged door and externally operable handle for stick operation, lockable in OFF position; provide interlock to prevent opening front cover with switch in ON position.
  - a. Motor Circuit Protector: NEMA AB 1, circuit breakers with integral instantaneous magnetic trip in each pole. Provide adjustable instantaneous magnetic trip for frame sizes 400 ampere and larger.
5. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch. Fuse Clips: Designed to accommodate Class J fuses.
6. Full Voltage Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower, full voltage starting, non-reversing type.
7. Two Speed Motor Controllers: One or two winding, constant torque, variable torque, or constant horsepower type as required. Include integral time delay transition between FAST and SLOW speeds.
8. Coil Operating Voltage: 120 volts, 60 Hz, verify with mechanical equipment
9. Motor Controller Overload Relay: NEMA ICS 2, melting alloy.
10. Auxiliary Contacts: NEMA ICS 2, 2 normally open/closed and field convertible contacts in addition to seal-in contact.
11. Control Power Transformers: 120 volt secondary, verify and provide as required.
12. FUSES – Refer to Section 260500.

**PART 3 - EXECUTION**

**3.01 PREPARATION**

1. Do not install busway when installation location is not protected from moisture.

**3.02 INSTALLATION**

1. Install busway and accessories in accordance with manufacturer's instructions.
2. Tighten joints using a torque wrench, to manufacturer's specified values.
3. Install busway length with expansion fitting at each location where busway run crosses building expansion joint.
4. Mounting and Support: Mount horizontal busway runs in flatwise or upright position as indicated, in accordance with Section 260548. Support busway as recommended by manufacturer. Support vertical riser at each floor.
5. Install busway with integral fire stops located where busway penetrates fire-rated walls and floors. Seal around opening to maintain fire-rating equal to wall or floor rating.
6. Provide concrete curb around interior floor penetrations.
7. Install busway with integral weather seal located where busway penetrates exterior wall or roof. Provide wall or roof flange and seal around opening to maintain weathertight installation.
8. Provide engraved plastic nameplates under the provisions of Section 260000.
9. Select and install heater elements in motor starters to match installed motor characteristics.
10. Motor Data: Provide neatly typed label inside each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

**3.03 WARRANTIES**

1. Manufacturers' Warranties
  - a. The manufacturer shall warrant that the equipment which he has furnished is free from defects in material and workmanship. Obligations under this warranty shall be as follows:



- 1) The equipment manufacturer or supplier shall provide and pay for all labor, parts, accessories, materials, freight and other services to repair or replace any equipment or part thereof which, in the course of installation, start-up and testing is found to be defective.
  - 2) For a period of 18 months from date of acceptance by the Owner or twenty four months from date of shipment, the manufacturer shall replace any defective equipment or part thereof; freight costs for return of defective parts, and labor for parts replacement are the responsibility of the installing contractor.
  - 3) Performance - where equipment is specified by size, guarantee that it will have the capacity specified in the system in which it is installed.
- b. The final acceptance of the equipment will be made by the commissioning agent after the manufacturer has adjusted his equipment, tested the various systems, demonstrated that it fulfills the requirements of the drawings and specifications, and has furnished all the required certificates of inspection and approval. The acceptance will be provided in conjunction with the phasing of the project. Refer to the phasing documents for additional information and criteria.

END OF SECTION

SECTION 26 27 00 - ELECTRIC SERVICE

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.
2. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and section 260500 Basic Materials.
2. See other Division 26 sections for requirements of electric service distribution equipment not included herein.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' catalog data for the following service equipment:
  - a. Meter sockets.
2. Submit shop drawings for the following fabricated service equipment:
  - a. CT/PT cabinets, and including bus work and mounting hardware.

1.05 UTILITY FEES

1. Provide work, materials, and fees required and/or charged by the Electric Utility Company United Illumination and Mr. Bruce Preston, T: (203) 926-4426 relating to the establishment of electric service for the project.
2. Coordinate removal of existing service transformers with UI. Removal and disposal shall be by this contractor should the UI not want to take possession of the Transformers and related vault equipment. The UI owns the transformer pots.

PART 2 - PRODUCTS

2.01 METER SOCKETS

1. Provide meter sockets, which comply with requirements of the local utility company.

2.02 CT/PT CABINETS

1. Provide CT/PT cabinets and mounting hardware, which comply with requirements of the local utility company. Unless otherwise indicated, CT's and PT's for revenue metering will be furnished by the utility company.
2. Where so indicated, CT/PT cabinets shall be an integral component of the electric service distribution equipment.

2.03 TRANSFORMER VAULT/PAD

1. Provide precast or cast in place concrete transformer vault/pad for utility distribution transformer in accordance with utility specifications.
2. Precast transformer vault/pads shall meet United Illumination Mr. Bruce Preston, T: (203) 926-4426 requirements, size: 76" x 70" x 36" deep, suitable for 500-2500 kVA transformers.
3. Provide minimum of two (2) ground rods and #4/0 bare copper ground loop placed 12-inches below undisturbed earth and 12-inches from pad perimeter and bonded to the transformer per utility.
4. Conduit orientation: Facing the conduit opening on the top section of the pad, primary conduits shall be on the left side and secondary conduits shall be on the right side. Primary conduits shall have a 90-degree sweep up inside the pad.
5. Protection: Where subject to vehicular damage, provide 4-inch vertical steel pipes filled with concrete and locate one at each corner of the concrete pad or as required by Utility. Minimum height above grade shall be 60-inches, minimum depth below grade shall be 40-inches. Deliver the transformer after protection is installed.

2.04 MISCELLANEOUS MATERIALS

1. Provide painted plywood backboard, conduit, wire, and any other miscellaneous materials and hardware required by the utility company.

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 BASIC MATERIALS.

3.02 COORDINATION WITH ELECTRIC UTILITY COMPANY

1. Consult with the electric utility company for verification of scope of work to be performed. Perform work pertaining to the electric service in strict accordance with utility company standards and requirements. Verify service voltage, phasing, and connections. In event of conflict between design and/or scope of service, notify Architect in writing.

3.03 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT

1. Where applicable, receive utility company equipment at the property line, transport to indicated installation location, install and connect per utility company instructions.
2. Set field-adjustable GFP devices, where applicable, for pickup and time-current sensitivity ranges as indicated or directed by the Architect.
3. Identify service disconnecting means per NEC 230-70(b) and 230-77.
4. Bond and ground service entrance equipment in accordance with codes, utility company requirements, as indicated, and as specified in another Division 26 section.

3.04 FINAL INSPECTION

1. Upon completion of installation and testing of service-entrance equipment and electrical circuitry, arrange for final inspection by the utility company and local authorities, energize circuitry, and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

END OF SECTION

SECTION 26 32 00 - EMERGENCY POWER SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this Section in accordance with the requirements of Section 260000, General Provisions. 260050 Removals and Section 260500 Basic Materials.
2. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
3. See other Division 26 Sections for requirements of emergency system panelboards and other electrical distribution equipment not included herein.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' technical data for emergency power system equipment and components, including construction details, performance specifications, and mounting and installation instructions.
2. Submit project-specific shop drawings including the following:
  - a. Factory dimensioned layout and arrangement drawings. Typical catalog cuts are not acceptable.
  - b. Complete wiring diagrams for system components.
  - c. Complete rigging diagrams and assembly procedures for the generator and generator enclosure

3. Submit a listing and report of factory tests performed.
4. Submit certified field test report upon completion of work.
5. Submit complete operating and maintenance manual.
6. Submittals shall be tabbed and indexed for easy reference and location of submitted components (i.e. generator, radiator, silencer, fuel system, enclosure, load bank, etc.).
7. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

## PART 2 - PRODUCTS

### 2.01 GENERAL

1. Provide a complete integrated emergency power system including, but not limited to, engine-generator set, automatic transfer switches, fuel system, exhaust system, sound-attenuated weather protected enclosure, remote annunciation, and power distribution, as indicated and herein specified. The system shall provide specified voltage, power and frequency to the designated circuits and loads, including Uninterruptible Power Supply (UPS) loads, within 10 seconds of loss of utility power.
2. The emergency power system shall be in compliance with the following codes and standards:
  - a. NEC Compliance: Comply with applicable requirements of NEC Articles 700 (Emergency Systems) 702 (Optional Standby Systems)] pertaining to emergency standby systems.
  - b. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Stationary Combustion Engines and Gas Turbines", and NFPA 110 "Emergency and Standby Power Systems" (Level 1).
  - c. UL Compliance: Provide standby power generator system and enclosure components that are listed and labeled to UL 2200 standard.
  - d. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1 "Motors and Generators", and MG 2 "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators".
3. The system manufacturer shall have a factory-authorized parts and service facility within a reasonable distance of the jobsite.

2.02 ENGINE-GENERATOR SET

1. The engine-generator set shall be nominally rated as indicated on the drawings. The kW rating shall be at 0.8 power factor, 122°F/50°C ambient air temperature, for standby operation for the duration of any utility power outage. Motor-starting capability shall be as noted on the drawings at 90% sustained voltage with a maximum 25% voltage dip. The manufacturer shall provide oversized components as may be necessary to meet this requirement.
2. Engine
  - a. The engine shall be an 1800 rpm water-cooled compression ignition diesel. Engine shall meet specifications when operating on No. 2 (Grade DF-2) domestic burner oil. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil coolers, fuel transfer pump, fuel priming pump, and gear driven water pump. The engine shall be Cummins Model as noted on the drawings. The engine shall be configured for low exhaust emissions and comply with Tier 2 EPA guidelines.
  - b. The engine governor shall be isochronous electronic type and shall maintain frequency regulation not to exceed 0.25% (0.15 Hertz) from no load to full rated load.
  - c. The unit shall be mounted on a structural steel sub-base and shall be provided with adjustable spring-type seismic-rated vibration isolators.
  - d. Provide safety shut-offs for high water temperature, low water level, low oil pressure, overspeed and engine overcrank.
  - e. Provide a thermostat-controlled thermal circulation type jacket water heater to maintain engine jacket water at 90°F in an ambient temperature of 0°F.
  - f. Provide a crankcase emission control system that shall remove a minimum of 99% of crankcase emissions including NOX, hydrocarbon and oil.
  - g. An engine-mounted radiator with [duct flange and] blower type fan shall be sized to maintain rated operation at 122°F/ 50°C maximum outside air temperature. The radiator shall be stacked core design. The aftercooler circuit shall be rated at 140°F. The engine cooling system shall be filled with an anti-freeze solution of 50/50 ethylene glycol/ water mixture. Rotating parts shall be guarded against accidental contact per OSHA requirements.
3. Starting System
  - a. Provide engine-generator unit with a 12 or 24 volt (manufacturer's standard) DC electric starting motor with positive engagement drive capable of three complete cranking cycles without overheating.

- b. Provide a non-gassing lead calcium recombination type engine starting battery set of the heavy-duty diesel type to avoid requirements for ventilation. The battery set shall be of sufficient capacity to provide for one and one half minutes total cranking time without recharging. Include a corrosion-resistant battery rack, battery electric heating, and necessary cables and clamps.
  - c. Engine mounted battery charging alternator shall be 45 ampere minimum with solid-state voltage regulator.
  - d. Provide a current limiting battery charger located at the generator to automatically recharge batteries and to maintain at full charge. Charger shall float at 2.20 volts per cell and equalize at 2.40 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressors, DC voltmeter, DC ammeter, and fused AC input. AC input voltage shall be 120 volts. Amperage output shall be no less than 10 amperes.
4. Exhaust System
- a. Provide a critical grade exhaust silencer including rain cap along with appropriately sized piping to the engine exhaust manifold. The silencer shall achieve a minimum of 45-52 dBA attenuation. Final connection to the manifold shall be flexible stainless steel for vibration isolation. The silencer and piping shall be of high temperature and corrosion-resistant (aluminized shell & heads) construction.
5. Generator (Alternator)
- a. The generator shall be a three-phase wye-connected, grounded neutral, 60 Hertz, single bearing, four pole, synchronous type, **105°C** temperature rise as noted on the drawings for standby output, as noted on the drawings, volts with brushless exciter and shall be built to NEMA Standards. Shunt excitation is not acceptable. Class H insulation shall be used on the stator and rotor, and both shall be further protected with 100% epoxy dipped and baked impregnation. Stator shall be skewed with 2/3 pitch windings to minimize field heating and voltage harmonic effects. Generator shall be Onan Frame Size: as noted on the drawings or pre-pre-approved equal.
  - b. A generator mounted solid-state voltage regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be +/- 2% from no load to full rated load. Readily accessible voltage drop, voltage level and voltage gain controls shall be provided. Voltage level adjustment shall be a minimum of +/- 5%. One-step application of 100% rated load shall result in a voltage drop of no greater than 15% of rated, and recovery to steady-state shall be within 5 seconds. Generator output voltage distortion shall be less than 5% total harmonic distortion (THD) line-to-line and line-to-neutral when supplying full rated linear load with no greater than 3% individual harmonic content. To limit voltage distortion for non-linear load current harmonics, the generator per unit sub-transient reactance shall not exceed 0.11 at generator temperature rise rating under full load.



- 1) The manufacturer shall review the generator application, and the indicated loads served, to determine what level of filtering or derating, if any, is recommended or required for satisfactory regulator and generator performance. Provide equipment accordingly.
  - 2) Provide alternator anti-condensation heater, thermostatically controlled, 120 volt.
- c. Connection to the engine flywheel shall be via a semi-flexible disc coupling.
- d. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for more than 10 seconds.
- e. Provide unit mounted, three-pole, molded-case circuit breakers for life safety and stand-by loads at the generator output terminals in NEMA 1 enclosure(s) to protect the generator and the generator supply conductors against overload as indicated on the drawings. Each circuit breaker shall have a trip rating as indicated on the drawings. Provide 2 form "C" aux contacts.
- f. Provide service entrance rated disconnect switches as indicated on the drawings with overcurrent protection properly sized and set to provide overload protection for the generator supply conductors. Provide (2) two aux Form C contacts to signal the fire alarm control panel.
- g. Provide (2) sets of ear protection to reduce noise levels to 20 db for the person wearing the headsets. Provide rack to hang heads sets by entry door.
6. Engine-Generator Set Control:
- a. The generator set shall be provided with a microprocessor-based control system, which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
  - b. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of components in the system under the vibration conditions encountered.
  - c. The control shall be UL508 labeled, CSA282-M1989 certified, and meet IEC8528 part 4. Switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.

- d. The generator set mounted control shall include the following features and functions:
- 1) Three position control switch labeled RUN/OFF/AUTO: In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
  - 2) Red "mushroom-head" push-button EMERGENCY STOP switch: Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
  - 3) Push-button RESET switch: The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
  - 4) Push-button PANEL LAMP switch: Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
  - 5) Generator Set AC Output Metering: The generator set shall be provided with digital and analog metering set including the following features and functions:
    - a) 2.5-inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (kW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and kW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
    - b) Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, kW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display three phase voltages (line to neutral or line to line) simultaneously.
  - 6) Generator Set Alarm and Status Message Display: The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel (in addition, provide items designated (\*) to signal at remote annunciator):

pre-low oil pressure (alarm)\*  
low oil pressure (shutdown) \*  
oil pressure sender failure (alarm)  
low coolant temperature (alarm)\*  
pre-high coolant temperature (alarm)\*  
high coolant temperature (shutdown)\*  
engine temperature sender failure (alarm)  
low coolant level (alarm or shutdown--selectable)\*  
fail to crank (shutdown)  
overcrank (shutdown) \*  
overspeed (shutdown) \*  
low DC (battery) voltage (alarm)\*  
high DC (battery) voltage (alarm)\*  
normal DC (battery) voltage\*  
weak battery (alarm)\*  
battery charger malfunction\*  
low fuel-daytank (alarm or shutdown--selectable)  
high AC voltage (shutdown)  
low AC voltage (shutdown)  
under frequency (shutdown)  
over current (warning)  
over current (shutdown)  
short circuit (shutdown)  
over load (alarm)  
emergency stop (shutdown)  
generator running\*  
normal utility power\*  
EPS supplying load\*  
Not in auto\*  
Fault\* (owner selected condition)

- 7) In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- 8) Engine Status Monitoring: The following information shall be available from a digital status panel on the generator set control:  
engine oil pressure (psi or kPA)  
engine coolant temperature (degrees F or C; Both left and right bank temperature shall be indicated on V-block engines.)  
engine oil temperature (degrees F or C)  
engine speed (rpm)  
number of hours of operation (hours)  
number of start attempts  
battery voltage (DC volts)

- 9) The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
- 10) Control Functions: The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
- 11) The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
- 12) The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
- 13) The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
- 14) The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
- 15) Alternator Control Functions: The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from mis-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.
- 16) Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls

shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

- 17) Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
- 18) Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
- 19) An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
- 20) Provide a battery monitoring system to load test the batteries each time the engine is started. Test failure shall alarm when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- 21) When required by National Electrical Code or indicated on project drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.
- 22) Control Interfaces for Remote Monitoring - Control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
  - e. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
  - f. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
  - g. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

- h. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit continuously from the engine starting/control batteries.
  - i. The control shall be provided with a direct serial communication link using LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.
7. Remote Annunciator
- a. Provide a remote alarm annunciator, (18) light minimum (refer to 2.02-F-4-f), in a surface-mounted NEMA 1 enclosure containing indicating lights/LED's for low oil pressure, high water temperature, overspeed, overcrank, low battery, low fuel level, fuel tank leak, other indications for NFPA 110, Table 3-5.5.2 (d) Level 1 (refer to generator control panel requirements), and an alarm horn with silencing pushbutton and light.
  - b. Remote annunciator shall be powered by the genset storage battery.
  - c. The remote annunciator shall have provisions to signal a common emergency power system alarm to the building security system. (See other Division 26 section for security system requirements).
  - d. The remote annunciator located at the central control station shall have provisions for the manual start and transfer override features required in 2.04. Provide required wire and conduit between genset and remote annunciator.
8. Shutdown Switch
- a. Provide a breakglass-type remote manual shutdown switch per NFPA 110, 3-5.5.6. Switch shall be located at outdoor generator. Switch construction shall be weatherproof.
9. Sound Attenuated Weather Protected Enclosure
- a. Provide corrosion-resistant sound attenuated weather protected enclosure for engine-generator set made of heavy gauge reinforced steel. Enclosure shall be sized for the engine-generator set and local auxiliaries (batteries, charger, day tank/sub-base tank, and as specified and indicated). The enclosure shall be provided with necessary louvers, louver operators, maintenance access doors and heaters. Enclosures shall be Cummins Quiet Site Stage II or pre-pre-approved equal with measured sound pressure level performance as follows: average -70 dBA, maximum measured at 7 meters.
10. Acceptable Generator Manufacturers
- a. Subject to compliance with requirements, provide Cummins/Onan diesel engine-generator set Model as noted on the drawings. Series (Contact: Cummins-Metropower, Inc., Mr. Mike Ruty, T: 860-529-7474,

[michael.w.rutty@cummins.com](mailto:michael.w.rutty@cummins.com), Mr. Colm Kelly, T: 718-892-2400,  
([Colm.G.Kelly@cummins.com](mailto:Colm.G.Kelly@cummins.com))

- 1) Cummins/Onan
- 2) Caterpillar
- 3) Waukesha

### 2.03 FUEL SYSTEM & SUB-BASE TANK

1. Provide UL 142 listed sub-base tank and packaged fuel transfer system, size as hereinafter specified, complete with required connections and hardware.
2. The tank and all associated components shall be suitable for the application. Tanks with limitations on lengths of fill and/or vent piping shall not be permitted. Tanks shall have pressure ratings to comply with Code and local laws.
3. The tank shall be constructed of heavy gauge steel, have a removable gasketed inspection plate 6" square, fuel level gauge, and fuel inlet strainer. Tank construction shall be double-wall, with automatic interstitial leak detection and alarm.
4. The interior of the tank shall be epoxy coated and the exterior shall be rust-proofed and painted to match the color of the generator set.
5. Plumbing and wiring between the sub-base tank and the generator set shall be factory-installed.
6. Sub-base storage tank shall be sized for minimum 24 hour full load capacity, minimum 1200 gallon and be provided with appropriately sized and completely piped fill, drain, overflow and vent assemblies. Fuel system shall include: auxiliary hand pump, integral dual fuel transfer pumps, motors, starters, automatic level controls, solenoid valve(s) and alarms for trouble, leak, low and high fuel. Each pump and motor shall be appropriately sized by the manufacturer for the required GPM and lift. For outdoor units: The fuel transfer pump shall be mounted on the sub-base storage tank within the weatherproof generator enclosure. Each alarm shall indicate at the remote annunciator and signal a fault to the security system and Building Management/Automation System (BMS) and Building maintenance Office. Provide "Reset" switch to extinguish and clear alarms until next event. Provide piping between the sub-base tank and the main storage tank as specified under Division 23.
7. Provide the following dry contact outputs to the fuel oil pumping control system furnished by Division 15: Low fuel level (at 40% tank capacity), turn lead pump on (at 50% tank capacity), turn lead pump off (at 80% tank capacity), high fuel level (at 90% tank capacity), and leak detection in rupture basin. Provide total of 5 dry contact outputs to Division 23 control equipment.
8. Tank fill and vent piping shall be provided and installed by Division 23.
9. Provide remote fill alarm panel in NEMA 3R enclosure, adjacent to outdoor fuel fill lines. Provide wiring as required between sub-base fuel tank and monitoring panel. Pryco Inc., or pre-approved equal.

2.05 AUTOMATIC TRANSFER SWITCH

1. Provide electrically-operated, mechanically-held, double-throw automatic transfer switch, quantity and locations as indicated on the drawings, complying with the requirements of UL 1008 and NFPA 110, Level 1.
2. Voltage, ampere rating, and number of poles shall be as indicated. Fault withstand rating shall be suitable for the application, with the indicated upstream circuit protective device.
3. Four-pole switches shall be provided with full-capacity neutral switching.
4. Provide transfer switch mechanisms and control components factory assembled and wired in a wall mounting NEMA 1 enclosure with hinged, lockable door.
5. Electrical operation shall be accomplished by a non-fused momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions. Transfer switches using components of molded case circuit breakers, or contactors not designed for continuous duty repetitive switching between active power sources, are not acceptable.
6. Switch action for double-throw-type switches shall be mechanically held in both directions.
7. Overcurrent devices shall not be part of transfer switch products.
8. Provide switch with a manual operator, capable of transferring the switch to either source position for maintenance purposes. Control circuit shall be disconnected from electrical operator during such manual operation.
9. Provide the following ATS accessories and controls:
  - a. Close differential voltage sensing on each phase of normal source. Pick-up voltage shall be adjustable from 85 percent to 100 percent of nominal, and dropout shall be adjustable from 75 percent to 98 percent of the pick-up value. Factory set for pick-up at 95 percent and dropout at 85 percent.
  - b. Time-delay override of normal source voltage sensing shall delay transfer and engine start signals. Adjustable 0 to 6 seconds, and factory set at 2 seconds.
  - c. Voltage/frequency lockout relay and sensing of the emergency source shall be provided to prevent premature transfer. Voltage pick-up shall be adjustable from 85 to 100 percent of nominal. Factory set to pick-up at 90 percent of nominal. Pick-up frequency shall be adjustable from 90 percent to 100 percent of nominal. Factory set to pick-up at 95 percent. Provide adjustable time delay for transfer to emergency, 0 to 60 seconds, set at 0 seconds, to permit staggered transfer of multiple switches.
  - d. System test switch, momentary type, to simulate normal source failure.



- e. Retransfer time delay to normal source, adjustable from 0 to 30 minutes and factory set at 15 minutes. Provide automatic defeat of the delay upon loss of voltage or sustained undervoltage of the emergency source, provided the normal supply has been restored.
- f. Pilot lights to indicate source to which the load is connected.
- g. Engine starting contacts, one isolated normally closed and one isolated normally open. Contacts shall be gold flashed or plated and rated 10 amperes at 32 VDC.
- h. Engine cool-down time delay to run engine unloaded after retransfer to normal source, adjustable 0 to 30 minutes, set at 5 minutes.
- i. Engine-generator exercising timer, adjustable in 15 minute maximum increments, from 0 to 2 hours, for operation once a week, with load transfer.
- j. Unassigned Auxiliary Contacts: Two normally open contacts for each switch position, rated 10 amperes at 480 VAC. Refer to drawing E301 for use of these contacts.
- k. Source Available/Connected Indicating Lights: Provide a indicating light and engraved nameplate for each of the following:
  - 1) "NORMAL SOURCE AVAILABLE"
  - 2) "NORMAL SOURCE CONNECTED"
  - 3) "EMERGENCY SOURCE AVAILABLE"
  - 4) "EMERGENCY SOURCE CONNECTED"
  - 5) Supervision of sources shall be via the transfer switch normal and emergency source sensing circuits, respectively.
- l. Transfer Override Switch: To override automatic retransfer control so the ATS will remain connected to the emergency power source regardless of the condition of the normal source. Provide a pilot light to indicate the override status. Retransfer shall occur if the emergency source fails and the normal source is available.
- m. Selective Load (Elevator/BMS) Disconnect Contacts: Two (2) control contacts which operate with time delay prior to and/or after load transfer and retransfer (approximately 3 second delay).
- n. Provide each ATS with a factory-installed and wired internal in-phase monitor relay. The relay shall control transfer so it occurs when the two sources are synchronized in phase. The relay shall compare phase relationship and frequency difference between the normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees and only if the transfer can be completed within 60 electrical degrees. In-phase transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value.

- o. Door mounted digital meters consisting of voltmeter, ammeter, frequency meter and phase selector switch for phase-to-phase voltage sensing on both normal and emergency sources.
  - p. Provide load power and load current monitoring to measure load phase and neutral, current, power factor, real power (kW) and apparent power (kVA). Include trouble signal to warn of excessive neutral current resulting from unbalanced or nonlinear loads.
  - q. Provide relay module for adjustable transfer, pending time delay of 0 to 60 seconds and Normal and Emergency status signals, to prevent interruption of power during elevator operation. Relay outputs shall include: Source 1 Connected and Available, Source 2 Connected and Available, Not in Auto, Test/Exercise Active, and Pending Transfer (elevator signal).
  - r. Provide network interface for digital connection of the transfer switch to the owner's building automation system or other LonWorks® compatible system.
10. Acceptable Manufacturers
- a. Subject to compliance with requirements, provide Cummins Model OTPC [BT] automatic transfer switches or equal as manufactured by one of the following:
    - 1) Automatic Switch Company (ASCO) 7000 Series.
    - 2) Caterpillar CTS
    - 3) Russelectric.

### PART 3 - EXECUTION

#### 3.01 GENERAL

- 1. See Section 260500 BASIC MATERIALS.

#### 3.02 INSTALLATION

- 1. Install and connect generator sets and accessories where indicated, in strict compliance with manufacturer's instructions.
- 2. Coordinate fuel system, exhaust system, and combustion/cooling air requirements with Division 23.
- 3. Provide power, control, and signal wiring and connections as required for specified operation. Assure proper phasing of transfer switch normal and emergency source power connections.
- 4. Coordinate wiring of ATS auxiliary contacts and Selective Load (Elevator/BMS) Disconnect Contacts with Divisions 14 and 23. Provide wiring and conduit from these contacts to mutually-agreed termination locations at the Division 14 and 23 interface equipment. Refer to Sections 142400 and 230923.

5. Install a sign at the service entrance equipment indicating the type and location of the on-site emergency power source. Install a sign on the main grounding box identifying all emergency and normal sources connected at that location.
6. The enclosure manufacturer shall provide supervisory labor during the rigging and re-assembly of the generator set enclosure at the jobsite.

**3.03 FIELD ACCEPTANCE TESTING**

1. After completion of the emergency power system installation, perform a complete on site performance test per NFPA 110, Paragraph 7.13.
2. Testing shall be conducted by authorized representatives of the equipment manufacturer(s), and witnessed by the Owner's representatives and any interested local authorities.
3. Provide necessary calibrated test equipment, load banks, temporary cabling and connections, etc. as required to perform the testing in an pre-approved manner.
4. A certified report of test procedures, results, and any corrective measures taken shall be provided to the Owner.
5. Demonstrate operating procedures to Owner's personnel and provide written operating and maintenance instructions.
6. Tests and Approval:
  - a. Factory Test: The engine-generator shall be tested fully assembled at the factory with a 0.8 PF inductive load bank. The generator set shall conform to the performance criteria of this section.
  - b. The tests shall be conducted as follows:
    - 1) Operation at full rated load for a minimum of two hours.
    - 2) Records shall be maintained, throughout the test period on water temperature, oil pressure, ambient air temperature, voltage, current, frequency, noise readings, connected load and power factor.
  - c. On-Site Tests: The complete installation shall be tested for compliance with the Specification following completion of site work with a 1.0 PF resistive load bank for a minimum of 2 hours, or longer if required by NFPA 110 for specific occupancies and site conditions. Testing shall be conducted by representatives of the manufacturer, with required test equipment, witnessed by the Owner. Certified copies of test procedures and results shall be provided to the Owner.
  - d. On-Site load test shall repeat factory load test as described above and include the following:

- 1) Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
  - 2) Test (prior to cranking engine) for proper operation of accessories that normally function while the set is in a standby mode. Accessories include: engine heaters, battery chargers, generator and control enclosure strip heaters and remote annunciators.
  - 3) Check (during start-up test mode) for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
  - 4) Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown. Prior to this test, adjust transfer switch timers for proper system coordination. Monitor throughout the test engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
  - 5) Perform manual transfer of loads to generator simulating loss of automatic transfer switch operation.
  - 6) Adjust the load bank and inspect in accordance with the manufacturer's initial operation instructions.
  - 7) Test for proper interfacing and sequences of operation of ATS auxiliary and selective load shedding (elevator/BMS) contacts with equipment and sequences described herein, on the drawings, and in Division 23 Section 230923.
  - 8) Upon completion of installation, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner.
- e. Provide complete instructions, consisting of three (3) operating and maintenance manuals, parts books, dimensional drawings. Separate unit wiring diagrams, and schematics and interconnection wiring diagrams shall be provided.
- f. Owner Orientation: A representative of the supplier shall meet the Owner at the time of start up, and shall review the operation and parts books, starting and control methods, and recommended preventative maintenance procedures.
- 1) Furnish training as follows for a minimum of four employees of the system user:
- g. Training in the receipt, handling and acknowledgement of alarms.
- h. Training in the system operation including manual control of output functions from the system control panel.

- i. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
  - j. The total training requirement shall be a minimum of 24 hours or as required by the Owner, conducted on three successive days, but shall be sufficient to cover the items specified.
7. Refill fuel oil storage tank so that Owner is provided with full tank upon successful completion of testing. This shall be at no cost to the Owner.

### 3.04 TRAINING

- 1. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
- 2. The total on-site requirement training shall be a minimum of 32 hours or as required by the Owner, conducted on three successive days, but shall be sufficient to cover the items specified.

### 3.05 WARRANTY

- 1. Provide five (5) year comprehensive extended coverage for standby power applications. The complete electrical power system (generator set, controls, and associated switches, switchgear and accessories) as provided by the single source manufacturer shall be warranted by the manufacturer against defects in materials and workmanship for a period of five (5) years or 1500 hours, whichever occurs first from the date of system start-up. Coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment per the manufacturer's standard published limited warranty. There shall be no deductibles applied to said warranty.

### 3.06 MAINTENANCE SERVICES

- 1. The contractor and manufacturer shall furnish and provide an inspection, maintenance and repair contract in full compliance with the requirements of NFPA 110 for the duration of the project. Refer to the phasing documents for project duration and approximate time frames. The GC shall provide dates for project phasing. There shall be no deductibles applied to said inspection, maintenance and repair contract. The contract shall begin at the substantial acceptance of the generator equipment by the commissioning agent. The inspection, maintenance and repair contract shall end. This contractor provide a complete maintenance log for each piece of equipment.
  - a. The services offered under this contract shall be performed at no charge during the first year after system acceptance and the owner shall have the option of renewing for single or multiple years up to five years at the price quoted upon completion of the warranty period.
  - b. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

2. The contractor or manufacturer shall offer for the owner's consideration at the time of the facility substantial acceptance at the end of Phase 3.0, a priced inspection, maintenance and repair contract in full compliance with the requirements of NFPA 110. Refer to the phasing documents for additional information.
  - a. The services offered under this contract shall be performed at no charge during the first year after system acceptance and the owner shall have the option of renewing for single or multiple years up to five years at the price quoted upon completion of the warranty period.
  - b. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

END OF SECTION

SECTION 26 33 33 - EMERGENCY INVERTER SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
2. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
3. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.
4. Products shall be listed to meet the following standards:
  - a. UL 924 Standard for Emergency Lighting and Power Equipment
  - b. UL 1778 Standard for Uninterruptible Power Supply Equipment
  - c. ANSI C62.41: ANSI C62.45 (Category A & B)
  - d. FCC Class A
  - e. NEC, OSHA and NFPA 101 Life Safety Code

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers may be considered, subject to its acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Provide materials and products suitable for, and where applicable UL listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturer's technical data and product specifications for emergency inverter equipment.

2. Submit project-specific shop drawings for the following:
  - a. Cabinet plans, elevations, mounting information and dimensions.
  - b. Wiring diagrams clearly differentiating field and factory wiring. Include complete electrical schematics to show internal connections and interconnections required between systems for each installation.
  - c. Battery types, optional equipment, and accessories.
  - d. Certified performance data, service agreements, and warranty information.
3. Submit installation instructions, user manual, maintenance, startup and test procedures.
4. Submit short circuit, arc flash and overcurrent protection coordination study as described in Section 260000. Study shall accompany equipment submittals. Failure to include the study with the equipment submittals will cause the equipment submittals to be rejected.

#### 1.05 OPERATION AND MAINTENANCE DATA

1. Maintenance Data: Describe normal routine maintenance procedures. Include complete replacement parts list.

### PART 2 - PRODUCTS

#### 2.01 EMERGENCY INVERTER SYSTEM

1. Description: Provide a central source of sinusoidal emergency AC power for powering "normally off" and "normally on" loads. The transfer from utility power to battery power shall use no-break, sine wave output to maintain zero transfer time. System output capacity shall be as shown on drawings and shall initiate upon failure or interruption of the monitored AC utility line. The system shall be capable of powering any combination of electronic ballast, power factor corrected ballast, and self-ballasted fluorescent, incandescent or HID lighting, dimming systems, building management systems and other critical emergency or frequency sensitive electronic loads. The system shall deliver full kilowatt (kW) rating at unity power factor and operate loads ranging from 0.5 lagging to 0.5 leading power factor from 0-100% loading up to full kilovolt-ampere (kVA) rating for a minimum of 90 minutes.
2. Normal Operation: During normal operation, the charger maintains the battery at full capacity and constantly monitors the DC voltage across the battery terminals. Exit signs and emergency lights remain on during normal operation.
3. Emergency Operation: For a single zone and multiple zones, upon loss of normal AC utility power or brown out conditions exceeding a 20% drop from nominal voltage, the automatic transfer circuit switches the emergency load to the inverter output and the emergency loads in the affected zones remain on without interruption. Upon return of normal AC utility line power, the system shall recharge the batteries within 24 hours. Upon an inverter failure, the load shall automatically connect to the AC utility line.



4. Operating Environment: The central source shall be constructed to operate in an ambient temperature of 32-104°F and 0-95% relative humidity, non-condensing.
5. Test Exercise: The central source shall include a manual test function and automatic test function. Automatic test shall be user programmable and shall diagnose each subsystem and assure system ability to operate in emergency and normal modes. The system shall record in memory the last 20 inverter events including weekly and user programmed tests. Initial installation setup shall program self-diagnostic testing as follows:
  - a. Weekly - 5 minutes duration.
  - b. Annual - 90 minutes duration.
6. Low Voltage Disconnect: A low voltage disconnect (LVD) circuit inhibits inverter operation at 87-1/2% of the nominal battery voltage, and protects the batteries from deep discharge damage during prolonged power failures.
7. Input and Output Voltage:
  - a. Input voltage shall be 480/277 volts +10% to -15%, Three phase, 4-wire, 60 Hz with an AIC rating of 100,000 RMS symmetrical amperes.
  - b. Output voltage shall be 480/277 volts +/- 5%, three phase, 4-wire, 60 Hz +0.5Hz on inverter.
8. Overload and Short Circuit Protection: System shall sustain 110% overload and 150% surge capability for 10 minutes minimum at rated load output.
9. Battery Charger: Battery charger shall be software controlled, three step type to float-charge the batteries continuously during normal utility conditions. Following a utility failure the charger shall automatically recharge the batteries within 24 hours without any interruptions to the power supplied to the load.
10. Batteries: The batteries shall provide sufficient power to maintain the output voltage of the inverter at its rated load for a period of 90 minutes. The batteries shall be non-gassing sealed lead calcium recombination type to avoid requirements for ventilation and requiring no addition of water over the life of the battery. Batteries shall be separately enclosed and isolated from the electronics sections in a cabinet that permits maintenance without removal. The battery warranty shall be one full year followed by **14 year** pro rata period.
11. Features: Provide the following equipment with each system.
  - a. Normally ON Output Breaker: Used when the lighting fixtures are to be energized only during a power outage. The Normally ON circuit breakers shall be user programmable for a delay of up to 999 seconds; initial setting shall be 5 seconds. Provide positions for (8) single pole or equivalent double pole circuit breakers.

- b. Output Circuit Breakers (OCB's) with Alarms: Provide (14) positions with alarms (20 positions without alarms). Single pole 120V and 277V breakers shall use one position each, while double pole 240V breakers shall use two positions each.
  - c. Bypass Switch: Provide Maintenance Bypass Switch, (make-before-break-MBB or break-before-make-BBM) to permit transfer of protected equipment to direct AC utility power when performing maintenance on the system.
  - d. Remote Status Panel: Provide Remote Status Panel(s) as indicated on the drawings to monitor the system from a remote location(s), up to 1000 feet. Provide wiring as required in EMT conduit, and all modules and terminals for connection of remote panels.
  - e. Optional Run time: Provide 1.5 hour run time.
  - f. Facsimile Modem Communications Panel (FAX): Provide capability to transmit system operating status reports over a dedicated analog phone line.
  - g. System Monitoring Terminals (SMT): Provide capability to allow owner/user access to the RSP (Remote Status Panel) outputs, and both the Inverter and Alarm Active Relays.
12. Control Panel and Status Display: The system's controls and status indications shall be conveniently located on the front panel, and consist of:

Alarm Displays:

- High/Low Battery
- Near Low Battery
- Output Circuit Breaker Open
- Battery Capacity Abnormality
- Transfer Circuit Abnormality
- Thermal Overload
- Alarm Silencer
- System Test Switch
- Low Runtime
- High/Low AC Output
- Output Overload
- High Ambient Temperature
- High Heatsink Temperature
- User Test Alarm
- High Transformer Temperature
- Check Charger/Inverter/Battery
- Memory Check
- High PFM Res. Temperature
- Probe Missing
- High AC Input
- Call Service

System Status LEDs:

- AC Line
- Charging
- Ready
- Battery Power
- Alarm

Performance Function Displays:

- AC Output Volts
- DC Charger Current
- DC Input Volts
- AC Input Volts
- AC Input Amps
- Output KVA
- AC Output Amps
- Output Frequency
- Function Select Keypad and Digital Display

13. Options - Provide the following additional features:
  - a. SMT – Dry contacts to signal trouble or fault condition to the BMS.
14. Mechanical: Components, including batteries and output panelboard, shall be factory assembled, wired, and tested in acid resistant epoxy painted steel, free-standing, ventilated NEMA 1 cabinets. The battery and electronics cabinets shall be stackable to minimize floor space requirements. The system shall be UL listed.

2.02 ACCEPTABLE MANUFACTURERS

1. Subject to compliance with requirements, provide equipment and components manufactured by one of the following:
  - a. Dual-Lite “Spectron LSN Series”
  - b. Myers Power Products – “Illuminator Series C”
  - c. liebert
2. Substitute products, if approved prior to acceptance of bid in accordance with Section 260000, shall include manufacturer’s affidavit and testing data indicating equipment suitability and compatibility for powering dimming systems.

PART 3 - EXECUTION

3.01 GENERAL

1. See Section 260500 BASIC MATERIALS

3.02 INSTALLATION

1. Install and connect emergency inverter system in strict accordance with manufacturer's instructions. Connect output circuits as indicated.
2. Do not energize until inspected and tested as specified below.

3.03 STARTUP & TESTING

1. Provide factory start-up service for each emergency system to include on site assistance and supervision of trained, manufacturer's technicians to administer a point by point visual check of the systems, check of internal electrical connections, and contractor wiring. The factory technician shall start up each system, test each zone separately, and insure that internal components are functioning as designed.
2. After successful testing and startup, the service technician shall demonstrate system operation to the Owner's designated personnel.
3. Set central source periodic test program schedule per user instructions.
4. Refer to specification section 260000, paragraph 3.8 for maintenance requirements.

3.04 CLEANING

1. Clean electrical parts to remove conductive and deleterious materials.
2. Remove dirt and debris from enclosure.
3. Clean photometric control surfaces as recommended by manufacturer.
4. Clean finishes and touch up damage.

3.05 FACTORY START UP

1. Provide Factory Start Up to assure proper operation and installation of the POWERGUARD Inverter System. Include trained Factory Authorized Technician to administer an on site point-by-point visual check of the system. Include: a check of internal electrical connections, AC and Battery connections, system voltages and system parameters. Power up the system and test parameters, calibrate and recorded results. Perform a Battery Discharge Test to insure proper battery capacity. Correct any malfunctions. The Technician will instruct on site personnel on the operations and maintenance of the equipment. Provide (2) 4 hour training sessions for owner on (2) different days. The owner shall be provided with no less than 14 days notice for training scheduling.

3.06 EXTENDED WARRANTY, MONITORING & SERVICE AGREEMENT

1. Provide five year warranty of the electronics portion of the system. Include: continuous monitoring of the equipment by manufacturer's Factory Technical Support Group. Include: one yearly jobsite visit by a Factory Authorized technician to perform a battery discharge test, and a visual and electrical check of the equipment. Upon notice of any system's failures, the problem will be remedied via the remote connection or by sending a Factory

trained Authorized technician to the jobsite. Parts and labor, except batteries, shall be included in the Extended Warranty. Batteries shall carry their own pro rata warranty.

2. Provide an Annual visit by a Factory Trained Authorized to test system options and related accessories. Technician will perform a physical and mechanical inspection of batteries and battery connections. Include: test, calibration and recording of system charger output, battery float voltages, and input/ output settings.
3. Provide continuous monitoring of the equipment by the manufacturer. Review and analyze weekly, monthly and yearly system tests to detect early warning signs of system malfunctions. Correct as required.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

1. Work of this section shall be governed by the Contract Documents. Provide materials, labor, equipment, and services necessary to furnish, deliver and install work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

1.02 REFERENCES

1. Perform the work of this section in accordance with the requirements of Section 260000 General Provisions and Section 260500 Basic Materials.
2. See other Division 26 sections and architectural reflected ceiling plans for requirements of architectural luminaires, and of lighting control and dimming equipment and systems, not included herein.
3. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.

1.03 MATERIALS, EQUIPMENT AND SYSTEMS

1. Factory wiring of components shall conform to state and local codes and laws.
2. The criteria of design and performance to produce the required operation is based on equipment of the named manufacturers. Equipment of other manufacturers will be considered, subject to acceptability in the Engineer's judgment and opinion. The equipment must conform to the dimensions established by the drawings for mechanical spaces and other clearances.
3. Materials and products provided shall be suitable for, and where applicable UL or CSA listed and labeled for, the intended use or application.

1.04 SUBMITTALS

1. Submit manufacturers' technical product data for luminaires and components, including the following:
  - a. Dimensions.
  - b. Materials and construction.
  - c. Finishes.
  - d. Photometric data.
  - e. Ballasts (including normal, emergency and dimming).
  - f. Lamps.
  - g. Mounting accessories and details.

2. Submit scaled and dimensioned shop drawings for custom-fabricated luminaires, and for custom field assemblies.

## PART 2 - PRODUCTS

### 2.01 LUMINAIRES

1. Provide luminaires of sizes, types and ratings indicated, complete with, but not limited to, housing, lenses, louvers, baffles, lamps, lamp holders, reflectors, ballasts, starters, wiring and mounting accessories.
2. Luminaire types are indicated on schedules and drawings. Luminaires must comply with minimum requirements as stated therein or in the listed manufacturers' published data. Review architectural drawings and specifications to verify ceiling types, modules, and suspension systems appropriate to installation.
3. Subject to compliance with requirements and acceptance by the Architect, manufacturers other than those listed are subject to compliance with specification 260000, unless indicated "No Substitutions".
4. Coordinate with the ceiling system supplier to ensure that the luminaires and components supplied will be fully compatible with the ceiling system construction.
5. Recessed incandescent luminaires shall have built-in, automatic reset thermal protection, or be of low-temperature construction, as required by NEC 410-65 (c), and shall be provided with feed-through wiring boxes.
6. Provide electrical wiring within luminaire suitable for the ampacity and operating temperature.
7. Sockets for medium bi-pin fluorescent lamps shall be knife-edge type.
8. For exterior luminaires, hardware shall be stainless steel, even if painted; unpainted steel shall be hot-dipped galvanized after fabrication. Coordinate mounting hardware with the pole or surface to which mounted; bracket material and finish shall match the luminaire.
9. Lenses for fluorescent luminaires shall be prismatic acrylic, pattern 12, minimum 0.156 inch thick. Provide gasketing between enclosure and frame and between frame and luminaire housing.
10. Provide iridescent free reflectors and baffles for fluorescent luminaires.

2.02 BALLASTS

1. Ballasts shall be Class P, thermally protected, Certified Ballast Manufacturers (CBM)-listed, U.L., CSA or ETL-listed, and compatible with the luminaires, lamps, and voltage systems specified. Include end-of-life protection for detecting excessive voltages across the lamp that can occur when the lamp nears end of life and shuts the ballast down safely before these high voltages can do harm or damage. Provide universal voltage ballasts rated for 120 – 277 VAC input unless otherwise indicated. Where applicable, ballasts shall comply with Public Law 100-357 and local utility energy conservation criteria for energy efficiency, and with the requirements of FCC Part 18. Ballasts shall meet FCC EMI/RFI emission requirements for consumer equipment. Ballasts shall contain no PCB's.
2. Fluorescent ballasts for rapid-start lamps shall be high power factor, high frequency electronic type, sound rated A or better. Input Total Harmonic Distortion (THD) shall be less than 10% and ballast factor shall exceed 90%. Ballasts shall withstand line transients as defined in ANSI/IEEE C62.41, Category A. Ballasts shall be manufactured by Advance, Magnetek, Robertson or Sylvania, and shall come with a manufacturer's 5 year replacement warranty, including labor costs.
3. Fluorescent ballasts for pre-heat lamps shall be high power factor, trigger-start type. Pre-heat ballasts with starters are not acceptable.
4. Three-lamp fluorescent luminaires shall be provided with one 1-lamp and one 2-lamp ballasts, unless otherwise indicated. The center lamp of each shall be connected to the 1-lamp ballast.
5. Ballasts for compact fluorescent and T-5 twin-tube lamps shall be electronic type. Total harmonic distortion shall be less than 10%. Ballast shall maintain constant output for a line voltage variation of +/- 10%, have transient voltage protection per ANSI C62.41 Category A, be sound rated A, have power factor and ballast factor >90% throughout dimming range, start lamp at minimum temperature of 50°F, and have lamp end of life detection and shutdown circuit.
6. Furnish and install one (1) emergency battery ballast for each windowless space. Wire to constantly hot side of local lighting circuit. Emergency ballasts for fluorescent lamp emergency power supply shall be suitable for installation in ballast compartment of fluorescent luminaire. For luminaires not large enough to enclose the emergency ballast, provide a separate NEMA 1 enclosure accessible by removing the luminaire or ceiling tiles. Ballast output shall power each lamp for a minimum of 1100 lumens for 90 minutes. Battery shall be sealed lead calcium type, 5 year warranty, not pro-rated, with 7 to 10 year life expectancy. Include TEST switch and AC ON indicator light, installed to be operable and visible without disassembling luminaire. Emergency ballasts shall be Bodine B-50 ST (self-test) for tubular lamps and B-84C ST for compact lamps and LP600 ST (self-test) for low profile and space-limited fixtures or approved equal. Include Bodine Model KTS remote keyed test switch as indicated on drawings.



7. Where installed outdoors, in unheated areas, cold storage areas or areas below 50°F fluorescent ballasts shall be low-temperature type, suitable for 0°F operation. Emergency ballasts installed in unheated areas shall be Bodine B50Cold-Pak for linear fluorescent lamps, B4CF for compact fluorescent lamps or approved equals to withstand temperatures ranging from -4 °F to 131 °F and providing minimum 1200 lumens.
8. Provide HID lamp ballasts capable of operating lamp types with ratings indicated; constant wattage autotransformer magnetic type (CWA), multi-tap (120/208/240/277 volt), core and coil assembly encapsulated in non-melt resin; install capacitor outside ballast encapsulation for easy field replacement. Remote ballasts shall be provided by the fixture manufacturer with the proper lamp ignitor for remote applications. Provide wiring in accordance with manufacturer's recommendations to withstand lamp starting voltage and operating temperature. Coordinate installation requirements with manufacturer to assure code compliant installation.
9. Emergency ballasts for 175, 250 and 400 watt HID lamps with constant wattage autotransformer (CWA) ballasts shall maintain lamp arc for a minimum of two minutes until normal power is restored or emergency power takes over. Emergency ballasts shall be remote mounted up to 15 feet from HID fixture in a separate NEMA 1 enclosure. Battery shall be field replaceable, nickel cadmium type, 5 year warranty, not pro-rated, with 7 to 10 year life expectancy. Include charging indicator light. Emergency ballasts shall be Bodine Arc Keeper series or approved equal.
10. Fluorescent Electronic Dimming Ballasts
  - a. Dimmer shall be rated to control T-12, T-12 high output, T-8, T-5 and T-5 high output lamps at 120 VAC with the use of an interface. Lamps on the same circuit must have the same current rating (i.e., T-8), but may be different lengths (i.e., 3', 4').
  - b. Ballasts for fluorescent fixtures shall be Lutron Hi-lume "FDB" series or Lutron "ECO-10" series.
  - c. Provide remote wireless control where indicated on the drawings. Remote handheld device shall provide full range dimming with adjustable setpoints from 20-60 fc (210-640 lux) and ability to control up to 20 standard dimming ballasts in one zone.
11. The dimming performance shall be as follows:
  - a. One- and two-lamp ballasts shall track evenly, with no perceptible difference in light levels for the same type lamps.
  - a. Different lamp lengths on the same circuit shall track evenly, with no perceptible difference in light levels for the same type lamps.
  - b. Ballasts shall be inaudible with no apparent humming or buzzing at any point in the dimming range.

- c. Ballasts shall have: power factor greater than .95, ballast factor equal to .93, total harmonic distortion less than 10%, and lamp current crest factor less than or equal to 1.6.
- d. Ballasts shall be inaudible in a 27dB ambient throughout the dimming range.
- e. Ballasts shall be capable of striking lamps at any light level without first flashing to full light.
- f. Ballasts shall comply with FCC Part 18 regulations and shall not interfere with other properly installed electrical equipment.
- g. Ballasts shall have a minimum starting temperature of 10°C.]

2.03 TV STUDIO

- 1. Furnish and install the following for the TV studio:
  - a. 4'x4' 1 1/2" pipe grid from wall to and suspended from ceiling and walls.
- 2. The intent of this specification is to define parameters for furnishing and installing a complete working TV Studio lighting control system and complete set of luminaires to the owner. Performance deviations will not be accepted. These products have been specified due to their particular qualities desired for ease of installation and operation. The installing contractor is responsible for providing a complete system.
- 3. The scope of this work involves the following:
  - a. Field verification of dimensions, conditions and obstructions at the job site.
  - b. Provide and install theatrical lighting control console and console outlets as indicated.
  - c. Provide and install architectural lighting control panels as indicated.
  - d. Provide and install dimming system and wiring devices as indicated.
  - e. Install 60A 3-Phase Mains breaker for the dimmer rack.
  - f. Provide and install all required control wiring for DMX and LumaNet protocols. All components necessary to make the system a working network shall be included in the bid. Actual length of network cabling and system layout shall be verified in field.
  - g. Provide and install theatrical lighting fixtures. Install correct lamps, test and aim fixtures under the supervision of the engineer or his representative.
  - h. Remove all packaging and debris from job site. Clean all equipment to remove scratches, paint marks and finger marks.

4. Related Documents:
  - a. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.
  
5. Services:
  - a. **ON-SITE VISITS** - A factory-authorized representative of the manufacturer shall make two visits to the construction site to co-ordinate details of the installation and answer questions from the installing contractor. If necessary, the representative shall also direct the aiming of the theatrical fixtures. The representative shall be available by phone to act as personal liaison in resolving any installation problems. The representative shall maintain an office within the State of Connecticut. These services shall be provided at no additional cost to the installing contractor, distributor or end-user.
  - b. **ENERGIZATION** - A factory field service engineer shall visit the job site after installation is complete and prior to the energization of the system to inspect, test and adjust the system. She/he shall also at that time instruct the owners' representatives in the operation and maintenance of the system.
  - c. **FIXTURE AIMING** - The contractor shall supply two people and appropriate means of access such as ladders, scaffold or personnel lift at the time of fixture aiming which may or may not coincide with scheduled factory turn-on service for the control system.
  - d. **FOLLOW-UP TRAINING** - A factory-trained representative of the manufacturer shall provide an additional training session on-site after the final completion of the job at a time to be arranged with the end-users of the facility. A minimum of 4 hours of group or individual instruction in all aspects of operating the control system shall be provided at no additional cost.
  - e. **MANUALS** - The owner shall be supplied with two sets of "as-built" drawings at the completion of the installation. These drawings shall be part of an operations and maintenance manual covering all major items installed.
  - f. **WARRANTY** - Manufacturer shall furnish a minimum two year factory warranty on all parts and workmanship. Warranty to commence on the date the system is energized by the factory field service engineer.
  
6. Submittals:
  - a. Submittals shall include but not be limited to: complete bill of materials; one-line control riser that identifies, by product name, all dimming and control equipment as well as wire types and counts; cut-sheets on all proposed equipment showing full technical specifications, and a document identifying all deviations from this specification.

- b. Eight sets of B-size drawings shall be furnished for approval within 30 days of award of contract.
  - c. Fabrication shall begin only after approved drawings and a written notice to proceed have been delivered to the manufacturer at the manufacturer's place of business
  - d. The contractor shall be furnished with two sets of B-size installation drawings.
7. Execution:
- a. **SITE VERIFICATION** - Verify that all work which has been previously installed under other sections or by other trades, is acceptable for product installation in accordance with manufacturer's instructions. Report any problems to General Contractor and Owner's Representative before proceeding.
  - b. **FIELD MEASUREMENTS** - The electrical contractor shall be responsible for field measurements and coordinating the physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.
  - c. **INSPECTION** - Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.
8. Installation:
- a. The electrical contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The electrical contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control and dimming as described herein and shown on the plans. The electrical contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
  - b. Contractor shall comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.
  - c. Coordinate work with other trades to avoid conflicts of space or time and to allow work to progress in a timely manner.
  - d. The contractor shall test that all branch load circuits are operational before connecting loads to dimmer system load terminals, and then de-energize all circuits before installation.
  - e. Power shall not be applied to the dimming system during construction and prior to factory turn-on unless specifically authorized by written instructions from the manufacturer.

9. Testing:
  - a. NOTIFICATION - Upon completion of the installation, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout. Notification shall be given in writing a minimum of 18 days prior to the time factory-trained personnel are required on site.
  - b. TURN-ON - Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's factory-trained technician shall completely check the installation prior to energizing the system. Each installed dimmer system shall be tested for each level of brightness, proper ON/OFF operations, and proper LED illumination. Each installed control panel shall be tested with each scene: verifying that each dimmer-controlled fixture adjusts to the selected scene and that all scene-controller LED's illuminate properly.
  - c. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.
  - d. FINAL APPROVAL - All punch list items shall be corrected to owner's satisfaction and complete operation and maintenance manuals shall be presented to owner before final approval of completion is given.
10. Site Protection:
  - a. Contractor shall protect installed product and finished surfaces from damage including dents, scratches and paint overspray during all phases of installation including storage, preparation, testing, and cleanup.
11. Dimming System
  - a. Refer to specification section 260943 for additional specification requirements.
12. Warranty
  - a. A complete two (2) year warranty covering all parts and labor shall be provided for the control console and its peripheral devices. All software updates to the console released during the warranty period of the console shall be available to the owner free of charge.
13. Pipe Grid:
  - a. Furnish and install 1 1/2" black pipe "PIPE GRID", as provided by Drapka or pre-approved equal.

## 2.10 LAMPS

1. Provide lamps as indicated on drawings or schedules, or to suit the specified luminaires.

2. Fluorescent lamps shall be by the same manufacturer and shall be of the same color (3500K) with a Color Rendering Index (CRI) of 82 or higher for compact lamps and 85 or higher for other fluorescent lamps, unless otherwise indicated or required. Lamps of the same wattage, size and shape shall be identical.
3. Lamps shall be rated for dimming duty by the manufacturer where dimming control is shown on the drawings.
4. Incandescent lamps shall be 120 volt, inside-frosted (except PAR types), sizes and bases as indicated or required for luminaire compatibility.
5. High-intensity-discharge (HID) lamps shall be of the type and wattage specified, and compatible with the specified luminaires. High pressure sodium lamps for interior luminaires shall be diffuse-coated. Metal halide lamps for interior luminaires shall be phosphor-coated. Metal halide lamps for open luminaire operation shall be ANSI "O-rated" and include a quartz shroud around the arc tube to restrict end-of-life rupture. HID lamps for exterior luminaires shall be clear.

#### 2.11 ACCEPTABLE MANUFACTURERS

1. Cooper
2. Focal point
3. Erco
4. Neoray
5. Lightolier
6. Linear
7. AS indicated per luminaire

### PART 3 - EXECUTION

#### 3.01 GENERAL

1. See Section 260500 BASIC MATERIALS.

#### 3.02 INSTALLATION OF LUMINAIRES

1. Install luminaires at locations and heights as indicated, in accordance with luminaire manufacturers' written instructions, applicable requirements of NEC and NEMA standards, and with recognized industry practices, to ensure that luminaires fulfill requirements.
2. Electrical drawings show luminaire types, quantities, circuiting and approximate locations. Exact locations shall be as per the architectural drawings. Where exact dimensions are not given luminaires shall generally be centered in the room or area, equally spaced, sides parallel to walls, level, and in a straight line (for rows). Where conflicts occur or where exact locations cannot be determined, request clarification from the Architect.
3. Provide necessary boxes, canopies, stems, chain, and mounting hardware for a complete installation.

4. Luminaire suspension and mounting methods shall be capable of supporting the weight of the luminaire, plus the forces applied during re-lamping and maintenance.
5. Pendant fluorescent luminaires shall be stem or chain suspended as indicated. Individual luminaires shall have two supports, equally spaced from each end. Continuous rows with rigid couplers shall have supports near the center of each luminaire, equally spaced. Stem-supported luminaires shall be wired via one of the stems. In finished or semi-finished areas, outlet boxes and stem mountings shall be provided with decorative canopies. Chain-supported luminaires shall be wired with 3-conductor Type MC cables, strapped to the chain to provide a neat appearance, with appropriate cable connectors at each end. Pendant luminaires shall be hung plumb and level, parallel and perpendicular to walls.
6. In unfinished areas and areas without finished ceilings including but not limited to Mechanical Equipment Rooms, storage rooms and utility corridors, install luminaires after completion of ductwork and piping, in approximately the locations shown. Luminaires shall not be mounted above ducts or pipes where rendered inaccessible or where the light will be substantially blocked. Luminaires shall not be supported from ductwork or piping. In Mechanical Equipment Rooms mounting heights and exact locations shall be field-determined, but in no case shall mounting height be less than 7'-0". Provide necessary support as described in 260500.
7. Continuous rows of luminaires shall be rigidly aligned to provide a true straight-line appearance.
8. 2' x 2' fluorescent luminaires in any one area or corridor shall be mounted with the lamps oriented in the same direction.
9. Ceiling mounted lighting track sections, recessed downlights, outlet boxes, exit signs, etc. shall be securely mounted to the ceiling grid system and not supported by the acoustical ceiling tile only. Track shall be installed parallel and perpendicular to the grid system, unless otherwise indicated.
10. Lay-in troffers for exposed grid ceilings shall be provided with hold-down clips to prevent T-bar spread and subsequent falling of luminaire.
11. Recessed light fixtures, troffers and etc., shall be provided with flanges when shown to be installed in sheetrock ceilings, refer to architectural drawings. Furnish flanges for installation in sheetrock ceilings weather noted in luminaire schedule or not at no additional cost to the owner.
12. Recessed luminaires weighing more than fifty pounds shall not be installed directly on the concealed or exposed ceiling spline of a lightweight, mechanical acoustical ceiling system. Such fixtures shall be supported from the channel iron or the building structure.
13. Surface or pendant type luminaires, regardless of their weight, shall not be mounted directly on the concealed or exposed ceiling spline of lightweight, mechanical acoustical ceiling system. Such luminaires shall be supported from the channel iron or the building structure.

14. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.
15. Provide plaster frames for recessed luminaires installed in other than suspended grid types acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
16. Support surface mounted luminaires greater than 2' in length at a point in addition to the outlet box luminaire stud.
17. Extra care shall be taken in the handling of parabolic baffle and louver assemblies. Factory-installed plastic protection should be left intact until just before final job completion.
18. Fluorescent lamps shall be stored lying flat. Do not stand on end.
19. Install exit signs to be readily visible per Code and adjust locations up to five feet from locations shown on drawings at no additional cost.
20. Furnish and Install shatter tube and wire guards for luminaries with exposed lamps.
21. This contractor shall be responsible to survey the existing to remain portions of the project, reconnect existing to remain equipment and circuits. This contractor shall be responsible for the removal of exterior building light fixtures. In addition, this contractor shall provide the surveying of existing locations requiring a recess for the installation of new light fixtures. This contractor shall be responsible for providing a new light fixture recess and providing repair of existing exterior wall to like new standard.
22. Install flush mounted luminaires to eliminate light leakage between luminaire frame and finished surface.
23. Support surface mounted luminaires greater than 2' in length at a point in addition to the outlet box luminaire stud.
24. Extra care shall be taken in the handling of parabolic baffle and louver assemblies. Factory-installed plastic protection should be left intact until just before final job completion.
25. Fluorescent lamps shall be stored lying flat. Do not stand on end.
26. Install exit signs to be readily visible per Code and adjust locations up to five feet from locations shown on drawings at no additional cost.
27. Permanently attach emergency track luminaires to emergency powered sections of track lighting per manufacturer's recommended methods.
28. Wiring for 120 volt and 277 volt luminaires shall be run in separate raceway systems.
29. Size wiring for low voltage lighting fixtures according to voltage tables indicated on drawings.
30. Boots and duct connections for air-handling troffers will be furnished and installed under Division 15. Coordinate luminaire orientation and connection requirements. Retain side slot closures in place for adjustment by Balancing Contractor.



31. Provide plaster frames for recessed luminaires installed in other than suspended grid types acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

### 3.03 ADJUSTING AND CLEANING

1. Clean luminaires of dirt and debris upon completion of installation.
2. Protect installed luminaires from damage during remainder of construction period.
3. Adjust the aiming of adjustable floodlights, track-mounted luminaires, wall-wash luminaires, etc. as directed, or as required to direct the illumination to the intended locations. Where applicable, such adjustments shall be performed at night.
4. Level and grout pole and bollard bases.
5. Training shall be provided to personnel of the owners choosing. A minimum of (16) hours of training shall be provided to instruct in proper safety techniques, methods of access to light fixtures, lamp changing, ballast location and replacement, aiming, adjustments, and any unique issues related to specific light fixtures. Additional hours may be required for a complete training and teaching session. The following personnel is recommended to attend training and teaching session: Building maintenance staff, town electrician, and lighting manufacturer's local representative.

### 3.04 MAINTENANCE STOCK

1. At date of substantial completion, turn over to Owner, in original factory packaging, spare lamps equaling 10% of the installed quantity of each type, and spare ballasts equaling 5% of the installed quantity of each type, minimum two (6) of each type, provide (2) spare lamp per fixture for all types. Spare lamps shall be labeled with fixture type and fixture location. Four laminated, comprehensive, lists shall be provided to outline light fixture type and corresponding lamp and ballast type. Maintenance staff shall be provided (1.5) hours of additional training per fixture type. Training shall include aiming, adjusting and lamp changing.

### 3.05 LUMINAIRE SCHEDULE

1. Where luminaire is controlled by dimmers, and/or dimming systems provide dimmable ballasts. Dimmable ballasts shall be provided for luminaires controlled by dimmers and/or dimming systems.
2. In addition to specification section 265000, paragraph 3.05 B, Furnish and install dimming ballast's in the following rooms and areas:
  - a. Restaurant
  - b. Media center / library
3. Refer to architectural drawings for luminaire reflected ceiling plans in addition to the information shown on the following schedule:

**SECTION 26 50 00  
LIGHTING  
PAGE 13 of 21**

TYPE	MFGR.	DESCRIPTION	CATALOG #
A	Metalux	2x4 recessed fluorescent direct/indirect fluorescent Ovation series light fixture with center mount matte white reflector. Radio interference suppressor and a perforated direct lamp shield. Provide (3) 28 watt T5 lamps and (2) ballasts. Provide sheetrock flanges as required. Refer to architectural reflected ceiling plans for ceiling types.	2RDI-328T5RP-277V-EBT2-RIF1 and accessories EQ-CLIP-U and DF-24-W as required
A1	Metalux	2 x 4 specification grade recessed static troffer with (3) 32 watt T8 lamps, .156 thick #19 pattern acrylic lens. Radio interference suppressor. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flange as required.	2GCFA-332A19/156-277V-EB81-RLS-RIF1 and accessory EQ-CLIP-U.
A2	Metalux	2x4 recessed fluorescent direct/indirect fluorescent Ovation series light fixture with side mount matte white reflectors. Radio interference suppressor and perforated direct lamp shield II fixture with side basket. Provide (2) 28 watt T5 lamps. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flanges as required.	2RDI-S-228T5RP-277V-EBT1-RIF1 and accessory DF-24-W as required.
A3	Focal Point	1x4 surface mounted fluorescent direct/indirect Softlite I series with center basket and (2) 28 watt T5 lamps.	FSIS-PS-2T5-1C-277-S-SW-WH.
A4	Fail Safe	2x4 recessed gasketed fluorescent with .156" pattern 19 acrylic prismatic lens and (2) 32 watt T8 lamps.	CFE-3-232-277-89AG-EB81-RFI.
A5	Fail Safe	1x4 recessed gasketed fluorescent with .156" pattern 19 acrylic prismatic lens and (2) 32 watt T8 lamps.	CFE-3-12-232-277-89AG-EB81-RFI.

**SECTION 26 50 00  
LIGHTING  
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A6	Metalux	1 x 4 specification grade recessed static troffer with (2) 32 watt T8 lamps, .156 thick #19 pattern acrylic lens. Radio interference suppressor. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flange as required.	GCFA-232A19/156-277V-EB81-RLS-RIF1 and accessory EQ-CLIP-U as required.
A7	Corelite	2x4 surface mounted direct/indirect fluorescent light fixture with center mount matte white reflector. Perforated direct lamp shield. Provide (3) 28 watt T5 lamps and (2) ballasts.	R2-WL-3T5-2C-277-24-SU.
A8	Metalux	2x4 surface mounted fluorescent fixture with (3) 32 watt T8 lamps, .156 thick #19 pattern acrylic lens. Radio interference suppressor.	2M-332A19/156-277V-ER81-RLS-RIF1.
AOR	SRB Technologies	Betalux Area of Rescue sign. Provide Borosilicate (hard) glass, internally coated with zinc sulfide phosphor, wire guard in gym, pool, and locker room areas.	Model# 20 years, Multi-purpose sign WH- as required- RD-RM-as required—SC-Wireguard
B	Metalux	2X2 recessed mounted direct/indirect fluorescent troffer with two sided perforated lamp shield and (4) 14 watt T5 lamps and radio interference suppressor.	2RDI-S-414T5RP-277V-EBT1-RIF1.
B1	Metalux	2 x 2 specification grade recessed static troffer with (3) 14 watt T5 lamps, .156 thick #19 pattern acrylic lens, aluminum door, radio interference suppressor. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flanges.	2GCFA-314T5A19/156-277V-EBT1-RIF1 with accessory EQ-CLIP-U as required.
B2		Same as Type A2 above.	
B3		Same as Type B above.	
C1	Gamulux	6" wide direct recessed G-Beam Series fluorescent with (2) 54 watt T5HO lamps parabolic blade baffle and white high gloss finish. Provide in lengths as indicated on plans.	GB66SLRC-254T5HO-277V-ERS-4'-REC/T9W-PBB-WH.

**SECTION 26 50 00  
LIGHTING  
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D	Portfolio	Recessed (2) 26 watt fluorescent open downlight with specular clear low iridescent self flanged reflector and 277 volt electronic ballast. Provide dimming ballast where controlled by dimmer switch and / or dimming system.	C7226E-7251LI-WF.
D1	Halo	Recessed low voltage downlight with glass prismatic spread lens and 50 watt MR16 40°EXN flood lamp. Self flanged reflector and 120 volt to 12 volt transformer. Provide 277 volt to 120 volt step down transformer at each fixture.	H1499TAT housing and 1493W trim with L113 prismatic spread lens.
D2	Delray	Semi recessed downlight with opal glass diffuser and 42 watt triple tube fluorescent lamp. 277 volt.	4740.0.2
DL	Portfolio	Recessed (2) 26 watt fluorescent lensed downlight with specular clear low iridescent self flanged reflector, polycarbonate prismatic glass lens and 277 volt electronic ballast. Wet location label.	C7226E-7280LIIG-WF.
DR	Cole	Dark room 120 volt recessed light fixture. Provide with (2) dark red filter sections and (1) prismatic tempered glass center section. Provide (2) 15watt filter lamps and (1) 200 watt A23 A lamp.	PH810-3PB-1-DLT-1.
DR2	Cole	Dark room 120 volt recessed wall mounted "IN USE" light fixture. Provide green letters on white face, (1) 7 watt fluorescent lamp, single face.	S252-IN USE-F.
DS	Halo	Recessed shower light with (1) 26 watt fluorescent lamp and Fresnel glass lens and white trim ring. 277 volt ballast.	ERT552-PS.
DW	Portfolio	Recessed (2) 26 watt fluorescent open wall washer downlight with specular clear low iridescent self flanged reflector and 277 volt electronic ballast. Provide dimming ballast where controlled by dimmer switch and / or dimming system.	C7226E-7211LI-WF.

**SECTION 26 50 00  
LIGHTING  
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E	Sure-Lites	Emergency two head light fixture. Provide with Nicad batteries, self diagnostic. Wire guard where required, gym, pool, locker room. Wire to constantly hot side of local lighting circuit. Coordinate color with architect	CU-1-SD.
G	Louis Poulsen	LP Centrum series surface mounted pendant light fixture. Extruded clear anodized frame with spun aluminum shades and ballast compartment with white finish, clear glass lamp enclosure. White PVC covered stainless steel aircraft suspension cable and white power cord. Provide (1) 175 watt MH ED28 lamp.	LPC-1-175W-MH-ED28-MOGUL 277V-WHITE.
G2	Tech Lighting	Line voltage Ovation series pendant mounted fluorescent light fixture with hand pulled glass shade with tortoise shell finish, red glass ball detail suspended from a round satin nickel canopy and black wrought iron wrap. Provide with remote 277 volt dimmable ballast. 18 watt, GX24Q-2 BASE T4 compact fluorescent lamp at 277 volt. Mounted at 72" above finished floor.	700-TD-T-RN-S-CF277 with 700FJMOVLR-1 iron wrap.
G3	Shaper	22" surface ceiling mounted fluorescent light fixture with sapphire metal finish and hand painted faux alabaster bowl. 277 volt, (1) 22 watt T5 and (1) 40 watt T5 circular fluorescent lamps.	293-22-S-T5C/2/22/40-277V-SPE-FB.
G4	Tech Lighting	Line voltage Ovation series wall mounted fluorescent light fixture with hand pulled glass shade with tortoise shell finish and black wrought iron base. Provide with remote 277 volt dimmable ballast. 18 watt, GX24Q-2 BASE T4 compact fluorescent lamp at 277 volt. Mounted at 72" above finished floor.	700TDOVS-T-B-CF277.

**SECTION 26 50 00  
LIGHTING  
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G5	Portfolio	11" diameter pendant mounted fluorescent cylinder with aluminum white housing and low iridescent clear reflector and WD beam surface trim. (2) 42 watt fluorescent lamp, 277 volt and white pendant kit for mounting height as directed by the Architect.	C19-2-42-E-P-9250-LI with accessory C836P.
H	Neoray	12" wide perimeter direct-indirect Fenestra fluorescent wall wash fixture. Provide with continuous seamless run of reflector, totally shielded 277 volt,(1) 28 watt T5 lamp with electronic ballast. Lengths as required. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flanges as required.	114-T-R-1-T5-ETG-2-EB or provide SR ceiling type as required.
H1	Neoray	8" wide perimeter direct PentaFlex™ fluorescent wall wash fixture. Provide with continuous seamless run of reflector, totally shielded 277 volt, (2) 28 watt T5 lamps with electronic ballast. Lengths as required. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flanges as required.	79PF-2T5-as required-2-EB-SI.
H2	Linear Lighting	5-1/4" wide x 48" long recessed fluorescent fixture with white parabolic louver, radio interference suppressor. Provide (2) 28 watt T5 lamps, 277 volt and instant start ballast. Refer to architectural reflected ceiling plans for ceiling types and provide fixtures with sheetrock flanges as required	RC45-D-2-ET5-277-PBL-G-BW-10-RFI-4' or provide F Flanged mounting as required.
H3	Peerless Lighting	3-5/8" wide x 4-1/16" high surface mounted wall wash fluorescent fixture with specular asymmetric reflector and white finish. (1) 28 watt T5 lamp, 277 volt.	LLMW-S-128T5-as required-R4-277-GEB10-SCT-L/LP-C100.
H4	Neoray	6" wide x 8-1/4" high wall mounted GEO series direct-indirect fluorescent fixture with parabolic baffle. (2) 28 watt T5 lamps up and (2) 28 watt T5 lamps down, 277 volt electronic ballast Provide lengths as indicated on plans.	14DIW-22T5-as required-2-EB-SI-S79.

**SECTION 26 50 00  
LIGHTING  
PAGE 18 of 21**

J	Sportlite	22" diameter Starlitter Dome high bay compact fluorescent light fixture with clear prismatic poly dome. Provide (8) 42 watt, 277 volt compact fluorescent lamps, clear polycarbonate reflector, and flat clear lens, hook mounting, cord plug, receptacle, and wire guard.	TDX8-T42-2-1S-HCPL power pack and 22EXCP-22FLCPV-22/RING-22WG-T4235K fixture.
K	Metalux	1" high undercabinet light fixture with lens front. Length as required for a full coverage of cabinet. Provide with T5 lamps in lengths as required and 120 volt electronic ballast.	CL-as required-as required-EB-120V.
K1 - Ceiling	Stonco	Vapor tight ceiling mounted 100 watt incandescent light fixture for kitchen hoods. Provide with glass globe and cast guard. Provide wall or ceiling mounting as indicated on plans.	VCXL11GC
K1 - Wall	Stonco	Vapor tight wall mount ed150 watt incandescent light fixture. Provide with glass globe and cast guard. Provide wall or ceiling mounting as indicated on plans.	VWXL21GC
K2 – PIT	Stonco	Vapor tight wall mount 28 watt fluorescent light fixture. Provide with glass globe and cast guard.	VWXL28HFL-1 or 4 as required.
L	Metalux	4' heavy duty industrial aperture reflector chain hung fluorescent light fixture . Provide with wire guards, shatter tubes, (2) 32 watt T8 lamps, 277 volt electronic ballast and radio interference suppressor.	DMF-232-277V-EB81-RIF1 and accessory - WG/DI4FT-U and shatter tubes.
L2	Elliptipar	Style 302 linear 4' or 3' indirect cove fluorescent light fixture with (2)-28 watt T5 lamps specular extruded aluminum reflector and 277 volt operation in lengths as required.	F307-T128-S-00-2-00-0.
N	Ellipitipar	Style 124 linear 6' long indirect wall mounted pendant up light with white finish (4) 21 watt T5 fluorescent lamps, 277 volt, forward throw and extruded aluminum visor.	F124-D421-H-02-2-V0-0 with AMS-02-0 surface mounted hanger.

**SECTION 26 50 00  
LIGHTING  
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O	Portfolio	4-7/16" aperture recessed HID downlight with specular clear low iridescent alzak reflector, diffuse glass lens and white self flanged reflector trim ring. (1) 39 watt T6 G12 ceramic metal halide lamp and 277 volt electronic ballast.	M439T6G12E-4951L1-WF.
O1	Portfolio	4-7/16" aperture recessed HID downlight wall washer with specular clear low iridescent alzak reflector, diffuse glass lens and white self flanged reflector trim ring. (1) 39 watt T6 G12 ceramic metal halide lamp and 277 volt electronic ballast.	M439T6G12E-4981L1.
SL	Skytron	Stellar series surgical light with (1) 29" diameter and (1) 23" diameter light heads providing a total of 27,000 foot candles with wall control station consisting of individual on/off and intensity controls for each light head.	ST2923 and wall control station
T	Halo	Single circuit surface mount track system with all satin white components and accessories required for lengths as indicated on plans. Provide Mini Alto low voltage lampholder track heads as indicated on plans with satin white finish and (1) 50 watt 38° MR16 flood lamp.	L600P series track and LV308P with L2004P solid state track adapter.
X	SRB Technologies	Betalux exit sign. Provide Borosilicate (hard) glass, internally coated with zinc sulfide phosphor, wire guard in gym, and locker room areas. Provide a second sign with the international symbol of accessibility such symbol shall not be less than 6" high and be provided with directional chevrons	Model# 20 tears, WH- as required- RD-RM-as required—SC-Wireguard Provide security cover for low level exit signs. – SC Custom sign
XH	Sure-Lites	ES series Recessed, AC only, Edgelit led exit sign, red or green color and trim by architect. Chevrons and facing as indicated on the documents.	ES6-as indicated-BL, PS, BZPA, WH – as indicated- ceiling or wall as indicated.
XL	Concealite	Con-X recessed high abuse LED exit sign Architect to select letter color and finish of trim. Provide with high impact polycarbonate shield.	CR-RW –polycarbonate shield.



**SECTION 26 50 00**  
**LIGHTING**  
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XWL	Sure-Lites	UX series LED single face exit light, red letters, black finish, suitable for wet locations. Surface mounted to pole located in courtyards. Refer to Civil drawings for pole details.	UX6-1-R-BK.
S-1	Greenlee	8-5/8" diameter site bollard Hyperion series, heavy duty cast aluminum housing. Provided with concealed lens, heavy duty vandal resistant housing, 100 watt ceramic metal halide lamp, vandal resistant aperture, bronze finish.	HYPR-100CMH MT-OPTX-BRZ-FT-H42-LPC.
S-2	InVue	Site pole light fixture. Provide with 250 watt pulse start metal halide lamp, 277 volt, external house side shield as noted with 20' or 12' square pole height as indicated unless otherwise noted. Bronze finish on pole and light head. Reflector distribution as noted on plans. Provide vandal shield for 12' poles.	VXM-250-MP-277-as required-BZ with pole mounting as required. 20' or 12' poles as required.
S-3	Greenlee	Recessed weatherproof brass well light. Provide with (1) 70 watt, 277 volt metal halide, asymmetric wall wash flood optics, directional rock guard/shield, stainless steel trim, and drive over capability.	RDB-70MH-277-AWW-BLR-TR-TRKEY TDF-SST.
S-3a	Greenlee	Recessed weatherproof brass well light. Provide with (1) 39 watt, 277 volt metal halide, asymmetric wall wash flood optics, directional rock guard/shield, stainless steel trim, and drive over capability.	RDB-39MH-277-AWW-BLR-TR-TRKEY TDF-SST.
S-4	InVue	Site pole light fixture. Provide 100 watt pulse start metal halide lamp, quartz restrike lamp as noted, 12' round pole height unless otherwise noted, dark platinum finish, Architect to confirm color.	MSA-100-MP-277-4S-VS-BZ-EM/SC.
S-5	InVue	Wall mounted exterior light. Provide 100 watt pulse start metal halide lamp, bronze finish, forward throw reflector with tight up spot.	ENV-100-MP-277-MB-FT-TS-BZ-LGB-QAB-FRM.
S-5a	InVue	Wall mounted exterior light. Provide 100 watt pulse start metal halide lamp, bronze finish, forward throw reflector with tight up spot with integral photocell.	ENV-100-MP-277-MB-FT-TS-BZ-LGB-QAB-FRM-PC.

**SECTION 26 50 00  
LIGHTING  
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S-6	InVue	Architectural small flood light. Provide 150 watt pulse start G12T6 metal halide lamp, vandal shield, barn doors. One piece aluminum die-cast door, bronze in color, internal reflector, stainless tamper proof steel fasteners.	VFS-K-150-MP-277-VF-BZ and accessories VFS-BD-BZ, VFS-VS, and VFS-GL2.
S-7	InVue	Architectural small flood light. Provide 50 watt pulse start G12T6 metal halide lamp, vandal shield, barn doors. One piece aluminum die-cast door, bronze in color, internal reflector, stainless tamper proof steel fasteners, surface mount tenon, wall-mount arm.	VFS-K-50-MP-277-VF-BZ and accessories VFS-BD-BZ, VFS-VS, and VFS-GL2, SMT-BZ, WMT-BZ.
S-8	Greenlee	Architectural flood light distribution. Provide 175 watt G12-T6 MH Metal Halide lamp, vandal shield, barn doors, one piece aluminum die-cast door, bronze in color, internal reflector, stanchion mount black.	DRM2-HF-250-PSMU-F-MT-BLK with bracket BKA-DRM2-PWM-6-BLK and accessories BD, LS.
S-9	Bega	Recessed foot light with asymmetrical distribution. Provide (1) 39 watt G12T6MH metal halide lamp, concrete protection cover, one piece aluminum die cast faceplate, bronze color, internal reflector, stainless steel fasteners.	3042MH-BRZ with CPC 524.

END OF SECTION

## DESCRIPTION

The Ovation Series is a complete family of recessed direct/indirect luminaires featuring pleasant modern architectural styling, computer-designed optics and the latest energy efficient lamp and ballast technology. The luminaire combines a matte white indirect reflector and a perforated direct lamp shield to provide optimum brightness control. All components are located above the ceiling plane for a clean architectural appearance in the finished space. Carefully balanced design elements combine to provide an efficient and exciting alternative to traditional general lighting. Ovation is an excellent choice for a wide variety of commercial applications.

## SPECIFICATION FEATURES

### A... Construction

Nominal 6" deep housing is die formed of code gauge, prime cold rolled steel. Heavy gauge end plates are securely attached with screws for strength and rigidity and the elimination of gaps. Four auxiliary fixture end suspension points are provided. KOs for continuous row wiring. Large access plate for supply connection.

### B... Electrical\*

Ballasts are Class "P" and are positively secured. Rotor-lock lampholders ensure positive lamp retention. UL/CUL listed. Suitable for damp locations.

### C... Ballast Access

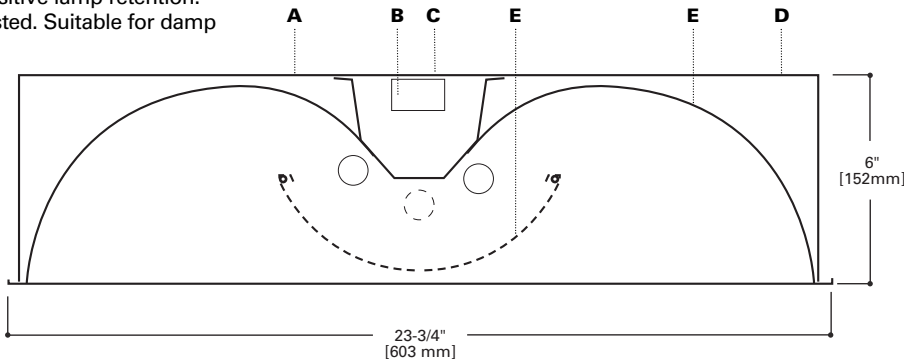
Ballast can be removed from below without tools.

### D... Finish

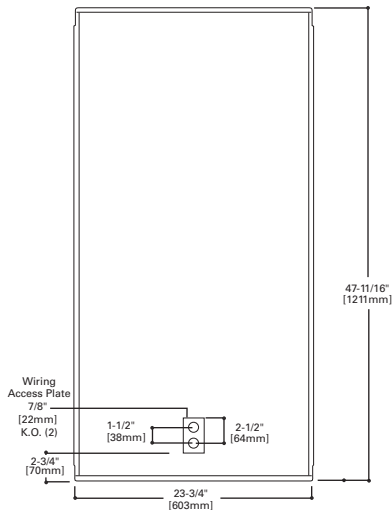
Durable cold rolled steel with multistage, iron phosphate pretreatment and white enamel finish to ensure maximum bonding and rust inhibition.

### E... Reflectors

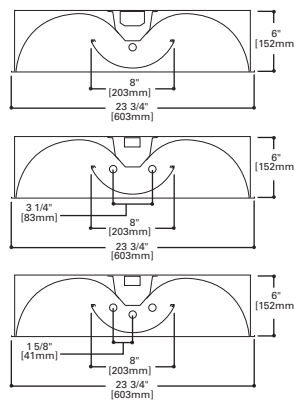
Indirect reflector has high reflectance baked matte white enamel finish for luminous uniformity. A positively retained direct lamp shield is constructed of heavy gauge perforated steel with high reflectance painted after fabrication finish and milky white overlay diffuser for visual comfort. All reflectors are precision formed in a computer-controlled operation.



## MOUNTING DATA



## LAMP CONFIGURATIONS



## CEILING COMPATIBILITY

G	T	F	Ceiling Type	Trim Type
Grid/Lay-in Standard	Slot Grid	Drywall Frame Kit	Exposed Grid	G
			Concealed T	G or T
			Slot Grid	G or T
			Flange	F

(Verify compatibility/ consult factory.)

Catalog #		Type	
Project		Date	
Comments		Prepared by	



**2RDI**  
**128T5**  
**228T5**  
**328T5**  
**154T5HO**  
**254T5HO**  
**354T5HO**

T5 OR T5HO LAMPS

2' X 4' Recessed  
 Direct/Indirect  
 Center-Mount

*Ovation*  
 15

## ENERGY DATA

Input Watts:

**EB Ballast & STD Lamps**  
 128T5 (34), 228T5 (68), 328T5 (102)  
 154T5 (54), 254T5 (106), 354T5 (160)

Luminaire Efficacy Rating

LER = FL71

Catalog Number: 2RDI-228T5RP

Yearly Cost of 1000 lumens,  
 3000 hrs at .08 KWH = \$3.38

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

\*\*Consult Pre Sales Technical Support.

\*\*\*See Drywall Frame Kit Accessory

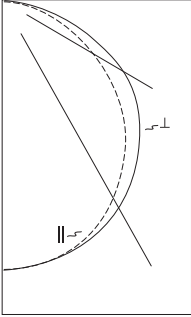
LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**

Safe and convenient means of disconnecting power.



PHOTOMETRICS



**2RDI-228T5RP**  
 Electronic Ballast  
 F28T5/835 Lamps  
 2600 Lumens  
 Spacing criterion:  
 (H) 1.2 x mounting  
 height, (L) 1.3 x  
 mounting height  
 Efficiency 76.9%  
 Test Report:  
 2RDI228T5RPIES  
 LER = FL71  
 Yearly Cost of 1000  
 lumens, 3000 hrs at  
 .08 KWH = \$3.38

Coefficients of Utilization

rc	Effective floor cavity reflectance																								
	80%						70%						50%												
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0%	
0	92	92	92	92	89	89	89	89	85	85	85	82	82	82	78	78	78	77							
1	83	79	76	73	81	77	74	71	74	72	69	71	69	67	68	67	65	63							
2	75	69	63	58	73	67	62	58	64	60	56	62	58	55	59	56	54	52							
3	68	60	53	48	66	59	52	48	56	51	47	54	50	46	52	48	45	43							
4	62	53	46	40	60	52	45	40	50	44	39	48	43	39	46	42	38	37							
5	57	47	40	34	55	46	39	34	44	38	34	43	38	33	41	37	33	31							
6	53	42	35	30	51	41	35	30	40	34	29	39	33	29	37	33	29	27							
7	49	38	31	26	47	37	31	26	36	30	26	35	30	26	34	29	26	24							
8	45	35	28	23	44	34	28	23	33	27	23	32	27	23	31	26	23	21							
9	42	32	25	21	41	31	25	21	30	25	21	30	24	21	29	24	20	19							
10	40	29	23	19	39	29	23	19	28	23	19	27	22	19	27	22	19	17							

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixture
0-30	994	19.1	24.9
0-40	1648	31.7	41.2
0-60	3026	58.2	75.7
0-90	3997	76.9	100.0
0-180	3997	76.9	100.0

Luminaire Data

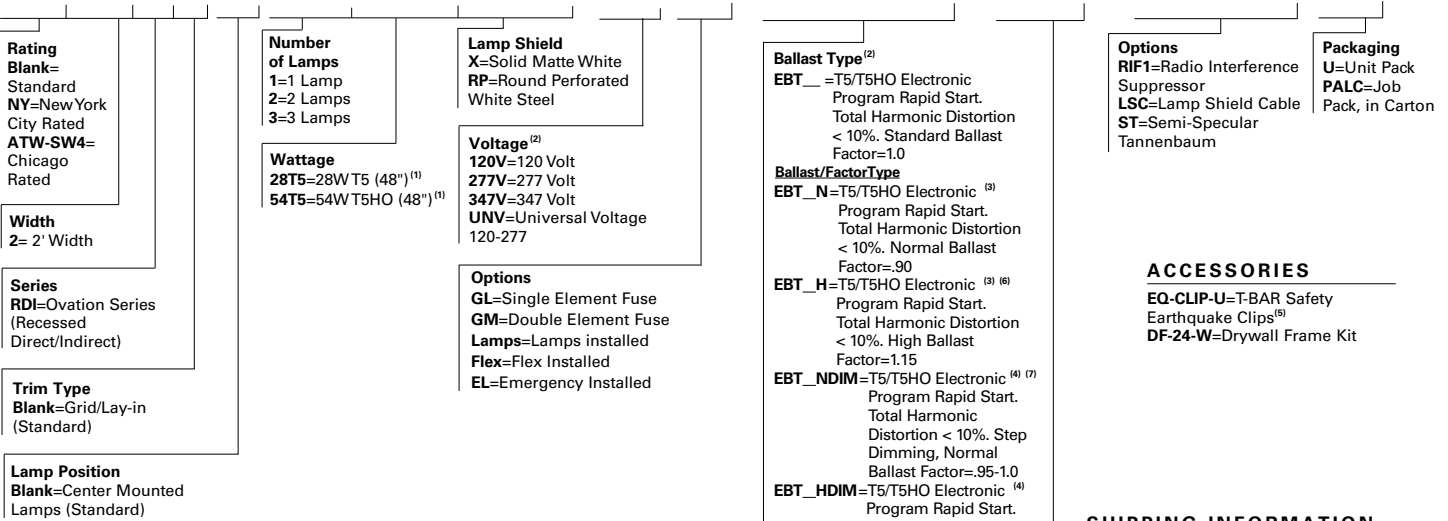
Angle in Deg	Average 0-Deg cd/sm	Average 45-Deg cd/sm	Average 90-Deg fcd/sm
45	1686	1895	2071
55	1585	1933	2236
65	1424	2017	2335
75	1205	1827	2065
85	857	1327	1428

Candela

Angle	Along H	45°	Across L
0	1258	1258	1258
5	1251	1255	1258
10	1234	1243	1250
15	1205	1221	1236
20	1164	1190	1213
25	1113	1151	1186
30	1052	1103	1149
35	981	1048	1104
40	901	986	1054
45	814	915	1000
50	720	837	942
55	621	757	876
60	517	673	791
65	411	582	674
70	308	472	518
75	213	323	365
80	128	196	211
85	51	79	85
90	0	0	0

ORDERING INFORMATION

SAMPLE NUMBER: 2RDI-228T5RP-120V-EBT1-U



ACCESSORIES

EQ-CLIP-U=T-BAR Safety Earthquake Clips<sup>(5)</sup>  
 DF-24-W=Drywall Frame Kit

SHIPPING INFORMATION

Catalog No.	Wt.
2RDI-128T5RP	28 lbs.
2RDI-228T5RP	28 lbs.
2RDI-328T5RP	28 lbs.
2RDI-154T5RP	28 lbs.
2RDI-254T5RP	28 lbs.
2RDI-354T5RP	28 lbs.

NOTES: <sup>(1)</sup> 2' x 2' and 2' x 4' Center Lamp Shield models only. <sup>(2)</sup> Products also available in non-US voltages and frequencies for international markets. <sup>(3)</sup> .90 and 1.15 ballast factor available for 2 or 3 28W T5 lamps only. <sup>(4)</sup> Step Dimming ballast available for 2 or 3 28W T5 lamps only. <sup>(5)</sup> An EQ Grid Clip is recommended for all 9/16" ceiling systems. Four required per fixture. <sup>(6)</sup> 1 lamp ballast in a high ballast factor not available. <sup>(7)</sup> 1 lamp step dimming ballast in a normal ballast factor not available. 2 lamp ballast will not operate 1 lamp.

For complete product data, reference the Fluorescent Specification binder. Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.



Visit our web site at www.cooperlighting.com

Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770.486.4801 10/10 ADF020609

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The GC Series features a 4-3/4" deep para-contoured fixture housing, high reflectivity and optimum lamp to lens spacing. The series produces total uniformity of light in the luminous area and is compatible with all of today's popular ceiling systems and is available with a number of options and accessories for application versatility.

The specification luminaire is designed to offer maximum efficiency and performance for today's unique interior specifications. The GC Series is an excellent choice for commercial office spaces, schools, hospitals or retail merchandising areas.

<b>Catalog #</b>		<b>Type</b>	A1
<b>Project</b>		<b>Date</b>	
<b>Comments</b>			
<b>Prepared by</b>			

## SPECIFICATION FEATURES

### A... Construction

4-3/4" deep, para-contoured housing, die formed, prime cold rolled steel. Die embossed housing has full length die formed stiffeners for added strength. Deep "V" ballast/wireway cover easily removed without tools. Die formed captive lampholder bracket fully encloses lampholder wiring permitting easy lampholder replacement. Heavy endplates are securely attached with interlocking tabs and screws. Four auxiliary fixture end suspension points provided. KOs for continuous row wiring. Endplates have integral Grid-Lock feature for safety and convenience.

### B... Electrical\*

Ballasts are CBM/ETL Class "P" and are positively secured by mounting bolts. Pressure lock lampholders. UL/CUL listed.\*\* Suitable for damp locations.

### C... Finish

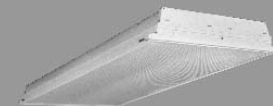
Multistage, iron phosphate pretreatment ensures maximum bonding and rust inhibitor. Lighting grade, baked white enamel finish.

### D... Hinging/Latching

Positive cam action spring loaded steel latches with baked white enamel finish. Safety-lock T-hinges allow hinging and latching either side.

### E... Frame/Shielding

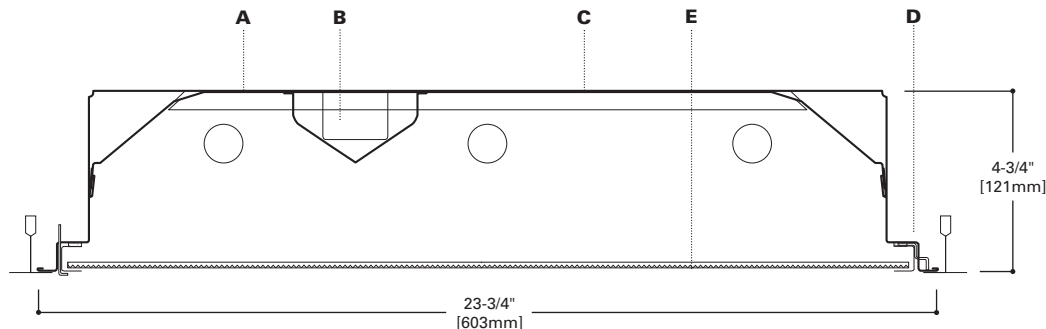
Die formed, heavy gauge, flat steel door with reinforced mitered corners and baked white enamel finish. Positive light seals. Light stabilized 100% virgin acrylic prismatic shielding. Standard #12 pattern. Optional shielding available.



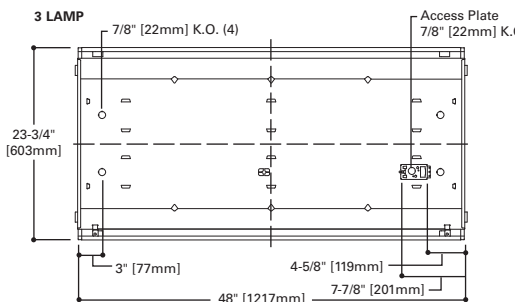
**2GC**  
**328T8**  
**332**

**2' X 4' TROFFER**  
**3 T8 LAMPS**

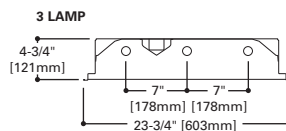
Specification Deep Troffer



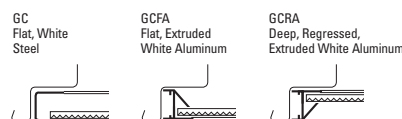
## MOUNTING DATA



## LAMP CONFIGURATIONS



## DOOR FRAMES



## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
328T8 (67)  
332 (81)

**ES Ballast & STD Lamps**  
328T8 (73)  
332 (86)

Luminaire Efficacy Rating

**LER = FL-67**

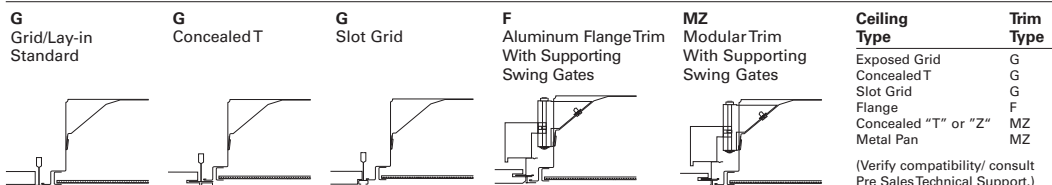
**Catalog Number: 2GC-332A**

**Yearly Cost of 1000 lumens,**  
**3000 hrs at .08 KWH = \$3.58**

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

\*\*Consult Pre Sales Technical Support.

## CEILING COMPATIBILITY



COOPER LIGHTING

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

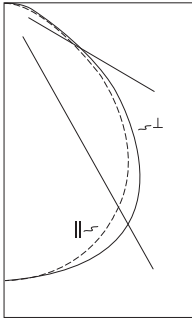
**LINEAR DISCONNECT**

Safe and convenient means of disconnecting power.

ADF081852



PHOTOMETRICS



**2GC-332A**  
Electronic Ballast  
F32T8/35K Lamps  
2800 Lumens

Spacing criterion:  
(II) 1.2 x mounting  
height, (H) 1.3 x  
mounting height

Efficiency 77.2%

Test Report:  
2GC332A.IES

LER = FL-67

Yearly Cost of 1000  
lumens, 3000 hrs at  
.08 KWH = \$3.58

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																	
	20%																	
	80%				70%				50%		30%		10%		0%			
rv	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																		
0	92	92	92	92	90	90	90	90	86	86	86	82	82	82	79	79	79	77
1	85	82	79	76	83	80	77	75	77	75	73	74	72	70	71	70	68	67
2	78	73	68	64	76	71	67	63	69	65	62	66	63	61	64	61	59	58
3	72	65	59	55	70	64	59	55	62	57	54	60	56	53	58	55	52	50
4	67	58	52	47	65	57	51	47	55	50	46	54	49	46	52	48	45	44
5	61	52	45	41	60	51	45	40	49	44	40	48	43	40	47	42	39	38
6	56	47	40	36	55	46	40	35	45	39	35	43	38	35	42	38	34	33
7	56	42	36	31	51	41	35	31	40	35	31	39	34	30	38	34	30	29
8	48	38	31	27	47	37	31	27	36	31	27	35	30	27	34	30	26	25
9	44	34	28	23	43	33	27	23	33	27	23	32	27	23	31	26	23	21
10	41	31	25	21	40	30	25	21	30	24	20	29	24	20	28	24	20	19

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	1978	23.5	30.5
0-40	3258	38.8	50.3
0-60	5465	65.1	84.3
0-90	6482	77.2	100.0
0-180	6482	77.2	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	64	68	62	66
30 x 30	60	62	57	60
30 x 60	53	55	48	51
60 x 30	62	65	61	64
60 x 60	53	56	50	52

**Candela**

Angle	Along H	45°	Across H
0	2476	2476	2476
5	2459	2473	2481
10	2429	2456	2478
15	2379	2425	2463
20	2306	2374	2426
25	2209	2300	2363
30	2087	2197	2272
35	1935	2060	2145
40	1743	1874	1958
45	1504	1627	1717
50	1238	1352	1442
55	984	1081	1147
60	765	826	861
65	573	590	610
70	409	386	427
75	278	252	317
80	183	183	236
85	96	111	134
90	0	0	0

**ORDERING INFORMATION**

SAMPLE NUMBER: 2GC-332A-UNV-EB81-U

<p><b>Rating</b> Blank= Standard NY=New York Rated ATW-SW4= Chicago Rated</p> <p><b>Width</b> 2=2' Width</p> <p><b>Trim Type</b> G=Grid/Lay-in (Standard)<sup>(1)</sup> G=Concealed T G=Slot Grid F=Aluminum Flange Trim<sup>(6)</sup> MZ=Modular Trim EMZ=Modular Trim (Extended Swing Arm)</p> <p><b>Series</b> C=Specification Deep Troffer</p> <p><b>Door Frame</b> Standard=Flat White Steel Door (Leave Blank) FA=Flush White Extruded Aluminum c/w Spring Latch RA=Regressed White Extruded Aluminum (3/8") FAN=Flush Natural Anodized Extruded Aluminum RAN=Regressed Natural Anodized Extruded Aluminum (3/8") FAB=Flush Black Extruded Aluminum RAB=Regressed Black Extruded Aluminum (3/8")</p>	<p><b>Number of Lamps<sup>(7)</sup></b> 3=3 Lamps</p> <p><b>Wattage</b> 28T8=28W T8 (48")<sup>(4)</sup> 32=32W T8 (48")</p> <p><b>Shielding</b> A=#12 Acrylic Pattern A125=#12 Pattern Acrylic (.125" Thickness) A19/156=#19 Pattern Acrylic (.156" Thickness) DA=Dropped Dish Matte White Acrylic IMA48=Injection Molded Acrylic (.150" Thickness) PB1S=1/2" x 1/2" x 1/2" Silver Parabolic Louver (Styrene)</p> <p><b>Option - Aluminum Flange Trim<sup>(6)</sup></b> Blank=SW (Single White) Type Color 'S' Single 'N' Natural 'R' In Row 'W' White 'E' End of Row</p> <p><b>Voltage<sup>(2)</sup></b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal Voltage 120-277<sup>(3)</sup></p>	<p><b>Options</b> GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed (Reference Flex ordering information) EL=Emergency Installed<sup>(5)</sup></p> <p><b>Lamps Installed</b> Blank=No Lamps Installed L8835=T8 Lamp, 28W and 32W, 3500K<sup>(4)</sup> L8841=T8 Lamp, 28W and 32W, 4100K<sup>(4)</sup> L8835HL=T8 Lamp, 32W, 3500K, 3100 Lumens L8841HL=T8 Lamp, 32W, 4100K, 3100 Lumens</p> <p><b>Ballast Type<sup>(3)</sup></b> EB8 =T8 Electronic Instant Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2 EB8 /PLUS=T8 Electronic Instant Start. High Ballast Factor &gt;1.13. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2 ER8 =T8 Electronic Program Rapid Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2</p> <p><b>HPT8 Ballast</b> HB8_L=T8 Electronic Instant Start. Low Ballast Factor .77 HB8 =T8 Electronic Instant Start. Ballast Factor .88 HB8_N=T8 Electronic Instant Start. Normal Ballast Factor 1.0 HB8_H=T8 Electronic Instant Start. High Ballast Factor 1.15-1.2 HR8_DIM=T8 Electronic Program Start Step Dimming. Ballast Factor .88 HR8_L=T8 Electronic Program Start. Low Ballast Factor .77 HR8 =T8 Electronic Program Start. Ballast Factor .88 HR8_H=T8 Electronic Program Start. High Ballast Factor 1.15-1.2</p>	<p><b>Options</b> RLS=Rotor Lock Socket (T8 Lamp only) RIF1=Radio Interference Suppressor 20GA/REP=20 Gauge Housing w/Riveted End Plate PAF=Painted After Fabrication</p> <p><b>Packaging</b> U=Unit Pack PAL=Palletized Uncartoned Fixtures PALC=Palletized Fixtures in Carton</p>
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**ACCESSORIES**

EQ-CLIP-U=T-BAR Safety Earthquake Clips<sup>(1)</sup>

NOTES: <sup>(1)</sup>An EQ Grid Clip is recommended for all 9/16" ceiling systems. Four required per fixture. <sup>(2)</sup>Products also available in non-US voltages and frequencies for international markets. <sup>(3)</sup>Not available when specifying emergencies, voltage must be specific. <sup>(4)</sup>When utilizing 28WT8 lamps, HPT8 Ballast must be specified. <sup>(5)</sup>Fixtures equipped with "EL" option may require a 5-1/2" housing depth. If installing in field, must use low profile battery pack. <sup>(6)</sup>Specify row configuration, type in catalog number when ordering complete fixture. <sup>(7)</sup>Standard off-center ballast on 3-lamp fixtures.

For complete product data, reference the Fluorescent Specification binder. Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.

**SHIPPING INFORMATION**

Catalog No.	Wt.
2GC-328T8A	31 lbs.
2GC-332A	31 lbs.



# COOPER LIGHTING - METALUX®

## DESCRIPTION

The Ovation Series is a complete family of recessed direct/indirect luminaires featuring pleasant modern architectural styling, computer-designed optics and the latest energy efficient lamp and ballast technology. The luminaire combines a matte white indirect reflector and two perforated direct lamp shields to provide optimum brightness control. All components are located above the ceiling plane for a clean architectural appearance in the finished space. Carefully balanced design elements combine to provide an efficient and exciting, high performance alternative to traditional general lighting. Ovation is an excellent choice for a wide variety of commercial applications.

## SPECIFICATION FEATURES

### A ... Construction

Nominal 6" deep housing is die formed of code gauge, prime cold rolled steel. Heavy gauge end plates are securely attached with screws for strength and rigidity and the elimination of gaps. Four auxiliary fixture end suspension points are provided. KOs for continuous row wiring. Large access plate for supply connection.

### B ... Electrical\*

Ballasts are Class "P" and are positively secured. Rotor-lock lampholders ensure positive lamp retention. UL/CUL listed. Suitable for damp locations.

### C ... Ballast Access

Ballast can be removed from below the ceiling.

### D ... Finish

Durable cold rolled steel with multistage, iron phosphate pretreatment and white enamel finish to ensure maximum bonding and rust inhibition.

### E ... Reflectors

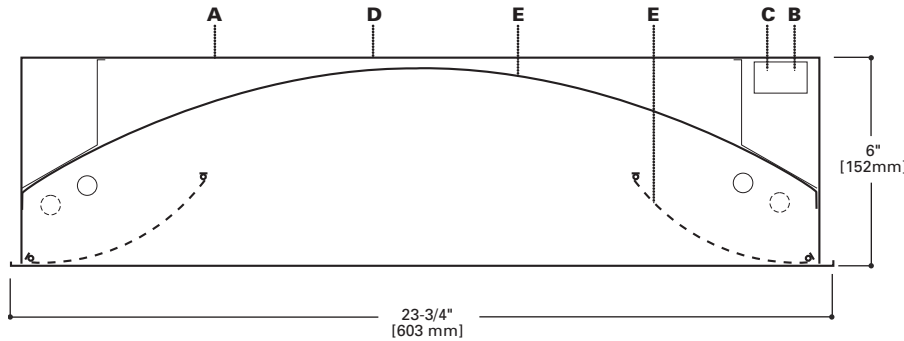
Indirect reflector has high reflectance baked matte white enamel finish for luminous uniformity. A pair of positively retained side-mounted direct lamp shields is constructed of heavy gauge perforated steel with high reflectance painted after fabrications finish and milky white over-layer diffuser for visual comfort. All reflectors are precision formed in a computer-controlled operation.

Catalog #		Type	A2
Project		Date	
Comments			
Prepared by			

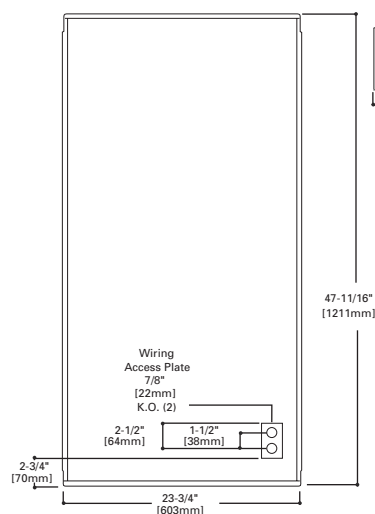


**2RDI-S-228T5**  
**2RDI-S-428T5**  
**2RDI-S-254T5HO**  
**2RDI-S-454T5HO**

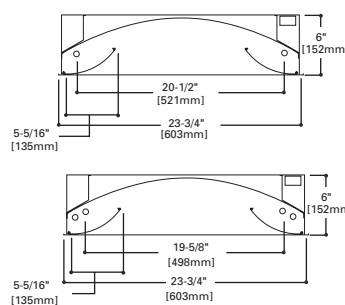
**T5 OR T5HO LAMPS**  
**2' X 4' Recessed**  
**Direct/Indirect**  
**Side-Mount**



## MOUNTING DATA



## LAMP CONFIGURATIONS



## CEILING COMPATIBILITY

G Grid/Lay-in Standard	T Slot Grid	F Drywall Frame Kit	Ceiling Type**	Trim Type
			Exposed Grid	G
			Concealed T	G or T
			Slot Grid	G or T
			Flange	***

## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
 228T5 (68)  
 428T5 (136)  
 254T5 (120)  
 454T5 (240)  
 Luminaire Efficacy Rating  
**LER = FL58**  
**Catalog Number: 2RDI-S-228T5RP**  
**Yearly Cost of 1000 lumens,**  
**3000 hrs at .08 KWH = \$4.14**

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

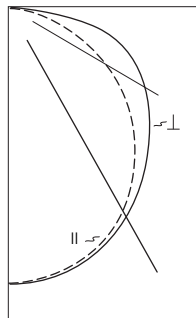
\*\*Consult Pre Sales Technical Support.  
 \*\*\*See Drywall Frame Kit Accessory

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**  
 Safe and convenient means of disconnecting power







**2RDI-S-228T5RP**  
Electronic Ballast

F28T5/835 Lamps  
2900 Lumens

Spacing criterion:  
( $\parallel$ ) 1.3 x mounting height, ( $\perp$ ) 1.3 x mounting height  
Efficiency 67.3%

Test Report:  
2RDIS228T5RP.IES

LER = FL58

Yearly Cost of 1000 lumens, 3000 hrs at .08 KWH = \$4.14

**Coefficients of Utilization**

rc	Effective floor cavity reflectance						20%											
	80%			70%			50%		30%		10%		0%					
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	0			
<b>RCR</b>																		
0	80	80	80	80	78	78	78	78	75	75	75	72	72	72	69	69	69	67
1	73	70	67	65	71	68	66	64	66	63	61	63	61	60	61	59	58	56
2	67	61	56	53	65	60	55	52	57	54	51	55	52	50	53	51	48	47
3	61	54	48	44	59	53	48	43	51	46	43	49	45	42	47	44	41	40
4	56	48	42	37	54	47	41	37	45	40	36	43	39	36	42	38	35	34
5	51	42	36	31	49	41	35	31	40	35	31	38	34	30	37	33	30	29
6	47	37	31	27	45	37	31	27	36	30	26	34	30	26	33	29	26	25
7	43	34	28	23	42	33	27	23	32	27	23	31	26	23	30	26	23	21
8	39	30	24	20	38	30	24	20	29	24	20	28	23	20	27	23	20	18
9	36	27	21	17	35	27	21	17	26	21	17	25	20	17	24	20	17	16
10	34	25	19	15	33	24	19	15	23	19	15	23	18	15	22	18	15	14

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	991	17.1	25.4
0-40	1626	28.0	41.7
0-60	2917	50.3	74.7
0-90	3902	67.3	100.0
0-180	3602	67.3	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	67	75	57	67
30 x 30	61	66	49	55
30 x 30	59	61	44	46
60 x 60	61	64	54	59
60 x 60	58	58	48	48

**Candela**

Angle	Along $\parallel$	45°	Across $\perp$
0	1269	1269	1269
5	1263	1260	1266
10	1248	1248	1252
15	1222	1223	1228
20	1183	1186	1192
25	1132	1137	1148
30	1070	1079	1096
35	996	1014	1037
40	913	941	975
45	820	863	912
50	719	781	849
55	609	698	784
60	494	616	718
65	378	537	654
70	270	458	584
75	180	374	486
80	108	257	297
85	42	79	105
90	0	0	0

**ORDERING INFORMATION**

Sample Number: 2RDI-S-228T5RP-120V-EBT1-U

<p><b>Width</b> 2=2' Width</p> <p><b>Series</b> RDI=Ovation Series (Recessed Direct/Indirect)</p> <p><b>Trim Type</b> Blank=Grid/Lay-in (Standard)</p> <p><b>Lamp Position</b> S=Side Mount</p>	<p><b>Number of Lamps</b> 1=1 Lamp 2=2 Lamps 3=3 Lamps 4=4 Lamps T1=2' x 4' fixture with one Biax Lamp at each end T2=2 Tandem Lamps (Biax) T3=3 Tandem Lamps (Biax)</p> <p><b>Wattage</b> 17=17W T8 (24") 32=32W T8 (48") 14T5=14W T5 (24") 24T5=24W T5HO (24") 28T5=28W T5 (48")<sup>1</sup> 54T5=54W T5HO (48")<sup>1</sup> BX40=40W Biax (24") BX50=50W Biax (24") BX55=55W Biax (24")</p>	<p><b>Lamp Shield</b> X=Solid Matte White RP=Round Perforated White Steel</p> <p><b>Voltage <sup>2</sup></b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal 120/277 Voltage</p> <p><b>Options</b> Lamps=Lamps Installed GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed EL=Emergency Installed</p>	<p><b>Ballast Type <sup>2</sup></b> Blank=Standard Magnetic Biax Ballast EB=Electronic Instant Start ER=T8 Electronic Program Rapid Start. Total Harmonic Distortion &lt; 10% TEB=T5 Biax Elec Instant Start. Total Harmonic Distortion &lt; 10% DLS=Digital Lighting System Dimming</p> <p><b>Lamp Size</b> 5=T5 Biax 8=T8 T=T5 Linear</p> <p><b>Number of Ballasts</b> 1= 1 Ballast 2= 2 Ballast 3= 3 Ballast</p>	<p><b>Options</b> PLUS=Higher Ballast Factor &gt; 1.13. Total Harmonic Distortion &lt; 20% RLS=Rotor Lock Socket (T8 Lamp only) RIF1=Radio Interference Suppressor REP=Riveted End Plates LSC=Lamp Shield Cable ST=Semi-Specular Tannenbaum</p> <p><b>Packaging</b> U=Unit Pack PALC=Palletized Fixtures in Carton</p>
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- Notes: 1 2' x 2' and 2' x 4' Center Lamp Shield model only.  
2 Products also available in non-US voltage and frequencies for international markets

**ACCESSORIES**

- EQ = T-BAR Safety Earthquake Clips (Use Four Per Fixture)  
DF-24-W = Drywall Frame Kit

**SHIPPING INFORMATION**

Catalog No.	Wt.
2RDI-S-228T5RP	25 lbs.
2RDI-S-428T5RP	25 lbs.
2RDI-S-254T5RP	25 lbs.
2RDI-S-454T5RP	25 lbs.





surface mount  
**softlite™ I**



**features**

Surface mounted direct/indirect with Matte Satin White reflector and perforated lamp shield.

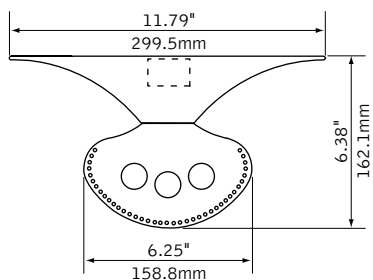
Two-piece sculpted end caps are removable to allow for continuous mounting of multiple luminaires.

Versatile design allows fixture to mount directly to drywall or to T-bar grid ceiling applications.

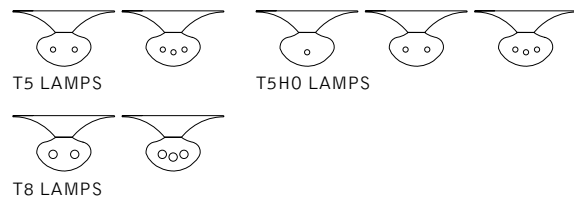
Lighting distribution provides illumination across the ceiling and walls.

Excellent choice for drywall ceiling or shallow plenum grid applications.

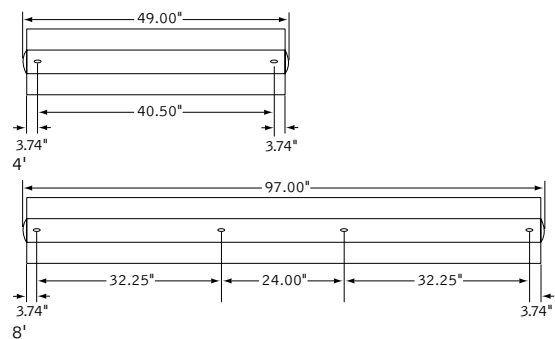
**dimensional data**



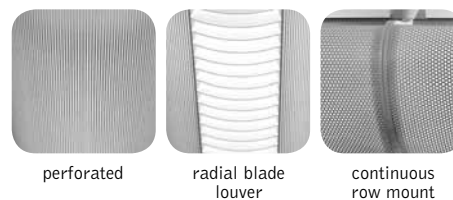
**lamping options**



**fixture information**



**shielding options & details**

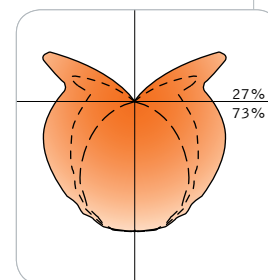


**companion luminaire**



**performance**

Perforated Lamp Shield  
2-Lamp T8  
79% Efficiency  
890 cd @ 5°

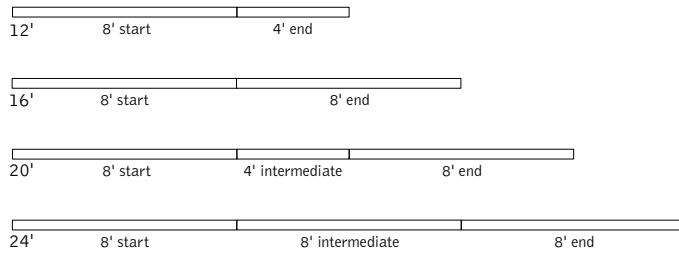


Visit [focalpointlights.com](http://focalpointlights.com) for complete photometric data.

fixture:

project:

### mounting information



Consult factory for additional row length information.

### specifications

#### construction

One-piece 20 Ga. steel housing.  
Die-cast aluminum end caps complete shield assembly.  
For row installation, internal brackets form hairline joint.

4' unit weight: 19 lbs.  
8' unit weight: 38 lbs.

#### optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.  
22 Ga. steel perforated lamp shield with white acrylic insert.  
Optional radial blade louver, .75"H x 1" frequency blade spacing.

#### electrical

Luminaires are pre-wired for specified circuits.  
Electronic ballasts are thermally protected and have a Class "P" rating.  
Optional dimming ballasts available.  
UL and cUL listed.

#### finish

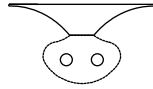
Polyester powder coat applied over a 5-stage pretreatment.

### ordering

<b>luminaire series</b>		<b>FS1S</b>
Softlite I	FS1S	
<b>shielding</b>		
Perforated Shield	PS	
Radial Blade Louver	RLP	
<b>lamping</b>		
2 Lamp T5	2T5	
3 Lamp T5	3T5	
1 Lamp T5H0	1T5H0	
2 Lamp T5H0	2T5H0	
3 Lamp T5H0	3T5H0	
2 Lamp T8	2T8	
3 Lamp T8	3T8	
<b>circuit</b>		
Single Circuit	1C	
Dual Circuit	2C	
<b>voltage</b>		
120 Volt	120	
277 Volt	277	
347 Volt	347	
<b>ballast</b>		
Electronic Instant Start <20% THD (T8 only)	E	
Electronic Program Start <10% THD	S	
Electronic Dimming Ballast*	D	
<b>mounting</b>		
Surface Grid	SG	
Surface Drywall	SW	
<b>factory options</b>		
Emergency Circuit*	EC	
Emergency Battery Pack*	EM	
HLR/GLR Fuse	FU	
Include 3500K Lamp*	L830	
Include 3000K Lamp*	L835	
Include 4100K Lamp*	L841	
<b>finish</b>		<b>WH</b>
Matte Satin White	WH	
<b>luminaire length</b>		
4'	4	
8'	8'	
12' (8' + 4')	12'	
16' (8' + 8')	16'	
20' (8' + 4' + 8')	20'	
24' (8' + 8' + 8')	24'	

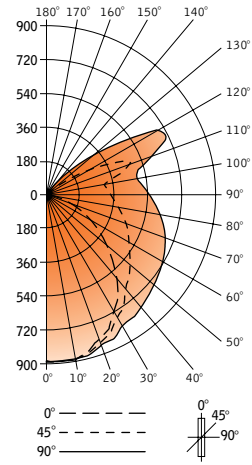
\* for more information see Reference section.

surface mount  
softlite™ I



Filename: FS1PS2T8.IES  
 Catalog #: FS1-14-B-2-T8-E-120-SM-PS-WH  
 Efficiency: 79%  
 Test #: 11996.0

CANDLEPOWER DISTRIBUTION



Spacing 1.2  
 Criterion: 1.5

Vertical Angle	Horizontal Angle				Zonal Lumens
	0°	22.5°	45°	67.5°	
0°	879	879	879	879	879
5°	888	887	888	890	890
15°	860	861	868	878	881
25°	785	788	811	834	846
35°	666	680	720	774	805
45°	505	531	617	718	762
55°	350	392	545	680	739
65°	196	281	479	638	700
75°	93	211	427	584	648
85°	22	167	360	515	577
90°	3	150	342	491	551
95°	13	135	319	461	517
105°	24	166	407	481	510
115°	21	39	381	662	712
125°	19	26	144	328	476
135°	0	15	30	144	187
145°	0	0	0	11	19
155°	0	0	0	0	0
165°	0	0	0	0	0
175°	0	0	0	0	0
180°	0	0	0	0	0

LUMEN SUMMARY

	Zone Lumens	% Lamp	% Fixt
0°-30°	707	12.0	15.3
0°-90°	3375	57.2	72.9
90°-130°	1198	20.3	25.9
90°-180°	1256	21.3	27.1
<b>Total Luminaire</b>	<b>4631</b>	<b>79</b>	<b>100.0</b>

LUMINANCE DATA (CD/M<sup>2</sup>)

Vertical Angle	0°	45°	90°
45°	1937	1547	1911
55°	1655	1467	1989
65°	1258	1439	2103
75°	975	1503	2281
85°	685	1588	2545

CO-EFFICIENTS OF UTILIZATION

Floor	80			70			20					
Ceiling	70	50	30	10	70	50	10	50	10	30	10	00
Wall	88	88	88	88	84	84	84	75	75	68	68	61
RCR 0	88	88	88	88	84	84	84	75	75	68	68	61
1												
2	79	74	70	66	74	70	63	63	58	56	52	50
3												
4	71	64	58	53	67	60	50	54	46	48	42	43
5												
6	64	56	49	43	60	53	42	47	38	42	35	38
7												
8	59	49	42	36	55	46	35	42	32	37	29	33
9												
10	53	43	36	30	50	41	29	37	27	33	25	29

Numbers indicate percentage values of

Go to [www.focalpointlights.com](http://www.focalpointlights.com) for additional photometric data.

## DESCRIPTION

The Fail-Safe CFE-3 Clean Room Troffer is enclosed and gasketed to maintain ceiling integrity and protect against infiltration of particles and airborne bacteria. The housing and door are designed to work with 1" or 1-1/2" inverted "T" ceiling grids. Sealed housing and door frame allow relamping without contamination of the clean areas. UL/cUL listed for wet locations, and manufactured in accordance with USDA, FDA, NSF and Federal Standard 209E guidelines.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

## SPECIFICATION FEATURES

### Application

The CFE-3 luminaires are ideal for I.E.S. Class 1,000, 10,000 and 100,000 clean room environments. Applications include clean rooms, technical and biomedical labs, and food processing/testing centers.

### Construction

Nominal 4-1/2" deep recessed, one-piece housing made of 20-gauge cold rolled steel; dieformed and seam-welded to create a sealed chamber. Gasketed wiring access cover.

### Finish

Electrostatically applied baked white polyester powder enamel

finish. Minimum reflectance 90%. Multistage cleaning cycle, iron phosphate coating with rust inhibitor. Conveyorized application and curing time accurately controlled at an elevated temperature.

### Frame/Shielding

Flush-mounted extruded aluminum door frame with mitered corners and baked white enamel finish. Flexi-seal closed-cell foam gasketing is used between lens frame and housing. One-piece extruded lens gasket provides a dependable seal between the lens and lens frame. Lens is clear Pattern 12 acrylic with prisms

positioned inside fixture and smooth surface on outside for easy cleaning.

### Hinging/Latching

Two slide-latches with safety screws secure lens frame in the closed position. Lens frame hinges and is removable without the use of tools.

### Electrical

Standard Class P, CBM/ETL ballast.

### Labels

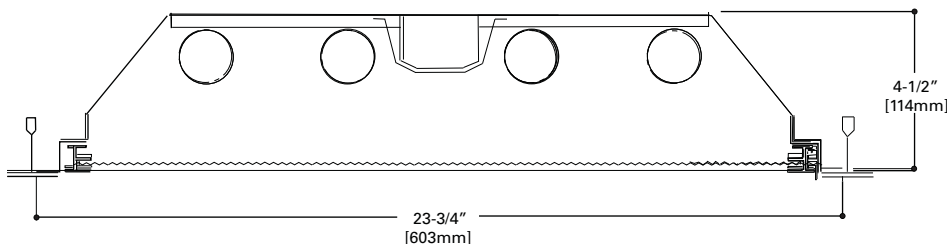
UL/cUL listed for wet locations, and manufactured in accordance to USDA, FDA, NSF and Federal Standard 209E. guidelines.



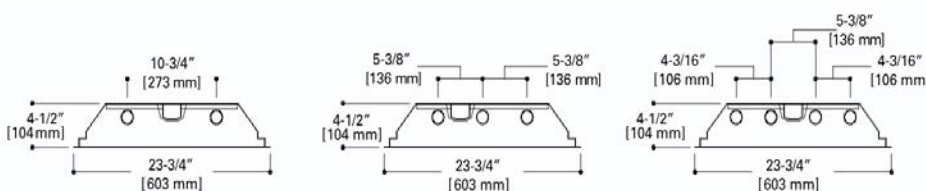
## CFE-3

2x4  
Cleanroom

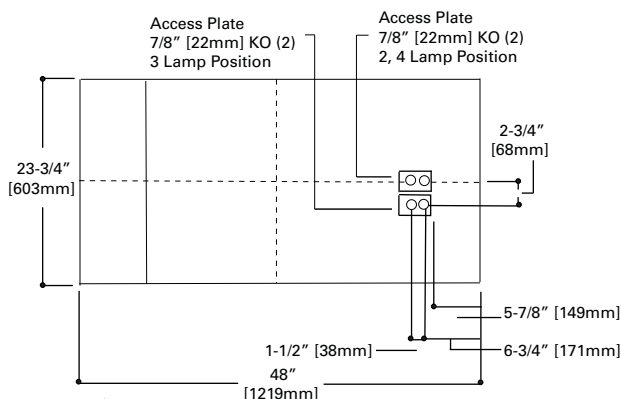
RECESSED GRID  
Inset Flat Door  
1" and 1-1/2" Grid



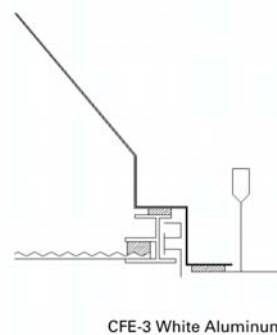
## LAMP CONFIGURATIONS



## MOUNTING DIMENSIONS



## DOOR FRAME



## ENERGY DATA

Input Watts:  
**ES Ballasts & STD Lamps**  
 232 (71 Watts)  
 332 (108 Watts)  
 432 (142 Watts)

### Electronic Ballast

Consult Cooper Lighting Representative.

**ORDERING INFORMATION**

SAMPLE NUMBER: CFE-3-232-120-IK12-EB81-GLR

Product Family	Grid Size	Lamp Type	Voltage	Shielding	Ballast	Options	Accessories (Order separately)
<b>CFE</b>	<b>3</b>						
CFE=Fluorescent Efficiency 3= 1-1/2"		<b>T8 Fluorescent</b> 232= (2) 32W Lamps 332= (3) 32W Lamps 432= (4) 32W Lamps 632= (6) 32W Lamps  <b>T5 Fluorescent</b> 228T5= (2) 28WT5 Lamps 328T5= (3) 28WT5 Lamps 428T5= (4) 28WT5 Lamps 628T5= (6) 28WT5 Lamps  <b>T5HO Fluorescent</b> 254T5= (2) 54WT5HO Lamps 354T5= (3) 54WT5HO Lamps 454T5= (4) 54WT5HO Lamps	120=120V 277=277V 347=347V UNV= 120V- 277V	IK12 = Pattern 12 Prismatic Acrylic, 0.110" nominal thickness 89AP= 0.125" Pattern 12 Acrylic IP12 = Pattern 12 Prismatic Polycarbonate 0.125" nominal thickness 93 = C73 Prismatic Tempered Glass, 0.156" thick 89BJ = 0.187" Pattern 12 Polycarbonate 89BM = 0.140" Pattern 12 Acrylic 89AR = 0.140" Pattern 12 Acrylic Acrytuf® 89AN= 0.187" Pattern 12 Acrylic Acrytuf® 89AG = 0.156" Pattern 19 Acrylic 89CB = 0.187" Pattern 19 Acrylic 89BV = 0.125" Clear Acrylic 89BW= 0.125" Opal Acrylic 90 = 0.005 UV absorbing overlay <sup>2</sup>	<b>Electronic Ballasts <sup>1</sup></b> EB81= (1) Ballast for use with T8 Lamp EB82= (2) Ballasts for use with T8 Lamp EB51= (1) Ballast for use with T5 Lamp EB52= (2) Ballasts for use with T5 Lamp	EBP=Emergency Battery Pack GLR=Fuse and Holder RIF=Radio Frequency Interference Filter  CFE-3-2x4 FLG Kit= Drywall Flange Kit, supplied with gasket	

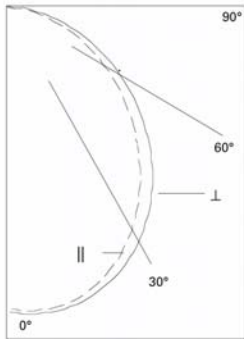
**NOTES:**

Electronic ballast may cause interference with other electronic devices. If interference occurs, move the device away from the product or plug/connect into a different circuit/outlet.

<sup>1</sup> For specific electronic ballast, specify brand and catalog number.

<sup>2</sup> To be used as inner layer with primary shielding. Example: 90/89CB = UV absorbing overlay and 0.187" Pattern 19 acrylic.

**PHOTOMETRICS**



**Coefficients of Utilization**

	Effective floor cavity reflectance						20%											
	80%		70%		50%		30%		10%		0%							
rc	80	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																		
0	89	89	89	89	87	87	87	87	83	83	83	80	80	80	76	76	76	75
1	82	79	76	73	80	77	74	72	74	72	70	71	69	67	68	67	65	64
2	75	69	64	60	73	68	63	60	65	62	58	63	60	57	61	58	56	54
3	69	61	56	51	67	60	55	51	58	53	50	56	52	49	54	51	48	46
4	63	55	48	43	61	54	48	43	52	47	43	50	46	42	48	45	41	40
5	58	48	42	37	56	47	41	37	46	40	36	44	40	36	43	39	35	34
6	53	43	37	32	52	42	36	32	41	36	31	40	35	31	39	34	31	29
7	49	39	32	28	48	38	32	28	37	31	27	36	31	27	35	30	27	26
8	45	35	28	24	44	34	28	24	33	28	24	32	27	24	31	27	23	22
9	42	31	25	21	40	31	25	21	30	24	21	29	24	20	28	24	20	19
10	39	28	22	18	38	28	22	18	27	22	18	27	22	18	26	21	18	17

**Candlepower**

Angle	Along	45°	Across ⊥
0	2610	2610	2610
5	2588	2597	2598
10	2528	2548	2564
15	2431	2469	2503
20	2298	2356	2409
25	2141	2225	2297
30	1980	2089	2175
35	1819	1950	2040
40	1647	1804	1891
45	1480	1650	1736
50	1310	1483	1568
55	1135	1305	1387
60	952	1110	1188
65	769	903	974
70	581	683	747
75	396	466	521
80	224	261	305
85	87	100	124
90	10	9	13

**CFE-3-340-IK12**  
Electronic Ballast

(3) F40T12 Lamps  
3150 Lumens each

Efficiency 74.9%

Plane: 0° 90°  
Spacing Criteria: 1.1 1.2

Report # 01710

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0- 30	1968	20.8	27.8
0- 40	3183	33.7	45.0
0- 60	5588	59.1	78.9
0- 90	7080	74.9	100.0
0-180	7080	74.9	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	52	59	48	54
30 x 30	48	50	44	46
60 x 30	51	52	48	50
60 x 60	47	46	42	42

## DESCRIPTION

The Fail-Safe CFE-3 Clean Room Troffer is enclosed and gasketed to maintain ceiling integrity and protect against infiltration of particles and airborne bacteria. The housing and door are designed to work with 1" or 1-1/2" inverted "T" ceiling grids. Sealed housing and door frame allow relamping without contamination of the clean areas. UL/cUL listed for wet locations, and manufactured in accordance to USDA, FDA, NSF and Federal Standard 209E. guidelines.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>A5</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

## SPECIFICATION FEATURES

### Application

The CFE-3 luminaires are ideal for I.E.S. Class 1,000, 10,000 and 100,000 clean room environments. Applications include clean rooms, technical and biomedical labs, and food processing/testing centers.

### Construction

Nominal 5-1/2" deep recessed, one-piece housing made of 20-gauge cold rolled steel; die-formed and seam-welded to create a sealed chamber. Gasketed wiring access cover.

### Finish

Electrostatically applied baked white polyester powder enamel finish. Minimum reflectance 90%. Multistage cleaning cycle, iron

phosphate coating with rust inhibitor. ConveyORIZED application and curing time accurately controlled at an elevated temperature.

### Frame/Shielding

Flush-mounted extruded aluminum door frame with mitered corners and baked white enamel finish. Flexi-seal closed-cell foam gasketing is used between lens frame and housing. One-piece extruded lens gasket provides a dependable seal between the lens and lens frame. Lens is clear Pattern 12 acrylic with prisms positioned inside fixture and smooth surface on outside for easy cleaning.

### Hinging/Latching

Two slide-latches with safety screws secure lens frame in the closed position. Lens frame hinges and is removable without the use of tools.

### Ballast

Standard Class P, CBM/ETL ballast

### Labels

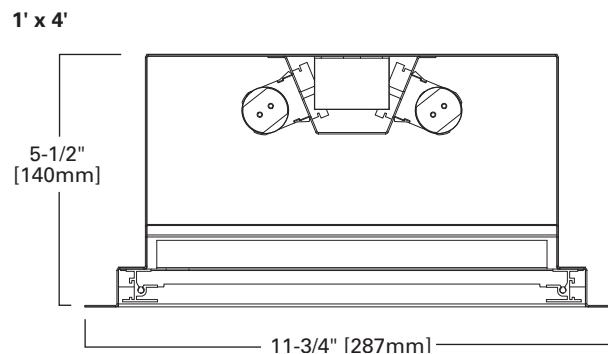
UL/cUL listed for wet locations, and manufactured in accordance to USDA, FDA, NSF and Federal Standard 209E. guidelines.



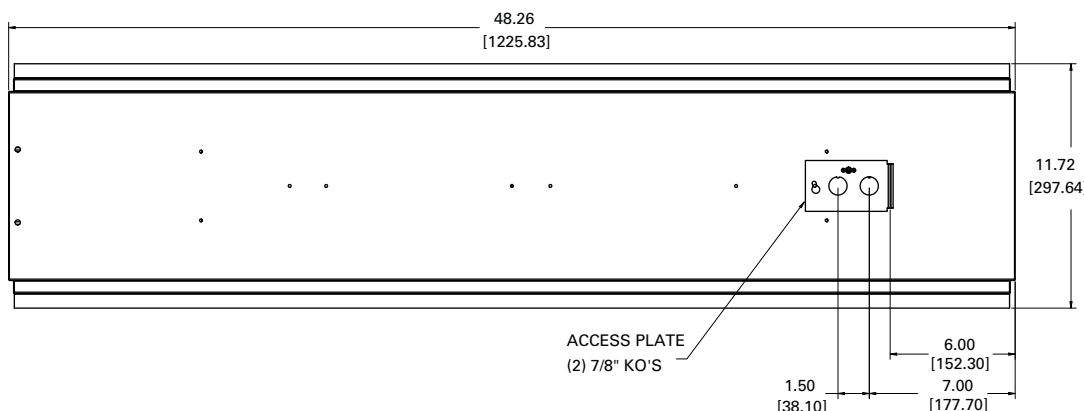
## CFE-3

1x4  
Cleanroom

RECESSED GRID  
Inset Flat Door  
1" and 1-1/2" T-Grid



## MOUNTING



## ENERGY DATA

Input Watts:  
**ES Ballasts & STD Lamps**  
 217 (45 Watts)  
 417 (90 Watts)  
 2U6 (82 Watts)

**ES Ballasts & ES Lamps**  
 2U6 (72 Watts)

### Electronic Ballast

Consult Cooper Lighting Representative

## ORDERING INFORMATION

SAMPLE NUMBER: CFE-3-12-232-UNV-IK12-EB81-GLR

CFE	3	12				
<b>Series</b> CFE=Fluorescent Efficiency			<b>Lamp Type</b> <b>T8 Fluorescent</b> 132=(1) 32W Lamp 232=(2) 32W Lamps 332=(3) 32W Lamps  <b>T5 Fluorescent</b> 128T5=(1) 28W Lamp 228T5=(2) 28W Lamps 328T5=(3) 28W Lamps 154T5=(1) 54W T5HO Lamp 254T5=(2) 54W T5HO Lamps	<b>Shielding</b> <b>IK12</b> = K-12 Prismatic Acrylic, 0.125" nominal thickness <b>IP12</b> = K-12 Prismatic Polycarbonate <b>93</b> = Prismatic Tempered Glass <b>89BJ</b> = 0.187" Pattern 12 Polycarbonate <b>89BM</b> = 0.140" Pattern 12 Acrylic <b>89AR</b> = 0.140" Pattern 12 Acrylic Acrytuf® <b>89AN</b> = 0.187" Pattern 12 Acrylic Acrytuf® <b>89AG</b> = 0.156" Pattern 19 Acrylic <b>89CB</b> = 0.187" Pattern 19 Acrylic <b>89BV</b> = 0.125" Clear Acrylic <b>89BW</b> = 0.125" Opal Acrylic	<b>Electronic Ballasts 1</b> <b>EB81</b> =(1) Ballast for use with T8 Lamp <b>EB82</b> =(2) Ballast for use with T8 Lamp <b>EB51</b> =(1) Ballast for use with T5 Lamp <b>EB52</b> =(2) Ballasts for use with T5 Lamp	<b>Options</b> <b>EBP</b> =Emergency Battery Pack <b>GLR</b> =Fuse and Holder <b>RIF</b> =Radio Frequency Interface Filter  <b>Accessories (Order separately)</b> <b>CFE-3-1x4 FLG Kit</b> =Drywall Flange Kit, supplied with gasket
<b>Grid Size</b> 3=1 1/2"			<b>Voltage</b> 120=120V 277=277V 347=347V UNV=120V-277V			
<b>Width</b> 12=12" Wide						
<b>Notes:</b> 1 For specific electronic ballast, specify brand and catalog number.						

## PHOTOMETRICS

Please contact customer service representative or visit our website @ [www.cooperlighting.com](http://www.cooperlighting.com).

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The GC Series features a deep para-contoured fixture housing, high reflectivity and optimum lamp to lens spacing. The series produces total uniformity of light in the luminous area and is compatible with all of today's popular ceiling systems and is available with a number of options and accessories for application versatility.

The specification luminaire is designed to offer maximum efficiency and performance for today's unique interior specifications. The GC Series is an excellent choice for commercial office spaces, schools, hospitals or retail merchandising areas.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		A6
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

## SPECIFICATION FEATURES

### A... Construction

5-5/8" deep, para-contoured housing, die formed code gauge, prime cold rolled steel. Die embossed housing has full length die formed stiffeners for added strength. Ballast/ wireway cover easily removed without tools. Die formed captive lampholder bracket fully encloses lamp-holder wiring permitting easy lampholder replacement. Heavy endplates are securely attached with interlocking tabs and screws. Four auxiliary fixture end suspension points provided. KOs for continuous row wiring. Endplates have integral Grid-Lock feature for safety and convenience.

### B... Electrical\*

Ballasts are CBM/ETL Class "P" and are positively secured by mounting bolts. Pressure lock lampholders. UL/CUL listed. Suitable for damp locations.\*\*

### C... Finish

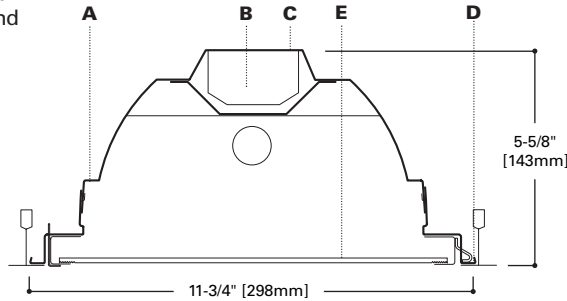
Multistage, iron phosphate pre-treatment ensures maximum bonding and rust inhibitor. Lighting grade, baked white enamel finish.

### D... Hinging/Latching

Positive cam action spring loaded steel latches with baked white enamel finish. Safety-lock T-hinges allow hinging and latching either side.

### E... Frame/Shielding

Flat extruded aluminum door with reinforced mitered corners and baked white enamel finish. Quadrased to prevent light spillage. Light stabilized 100% virgin acrylic prismatic shielding. Standard #15 pattern. Optional shielding available.



**GC**  
128T8, 228T8  
328T8  
132, 232, 332

1' X 4' TROFFER  
1, 2 OR 3 T8 LAMPS

Specification Deep Troffer

## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
128T8 (27), 228T8 (48), 328T8 (67)  
132 (30), 232 (55), 332 (81)

Luminaire Efficacy Rating  
**LER = FL-54**  
Catalog Number: GC-132A

Yearly Cost of 1000 lumens,  
3000 hrs at .08 KWH = \$4.44

Luminaire Efficacy Rating  
**LER = FL-56**  
Catalog Number: GC-232A

Yearly Cost of 1000 lumens,  
3000 hrs at .08 KWH = \$4.29

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

\*\*Consult Pre Sales Technical Support.

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

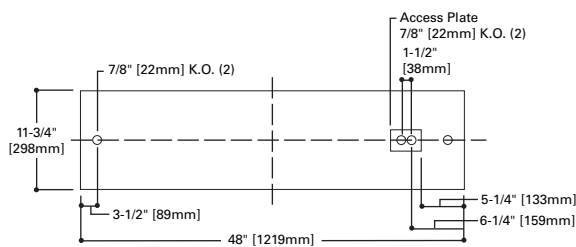
**LINEAR DISCONNECT**

Safe and convenient means of disconnecting power.



ADF090602

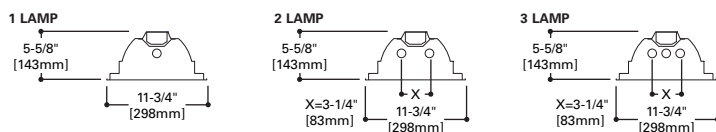
## MOUNTING DATA



## DOOR FRAMES



## LAMP CONFIGURATIONS



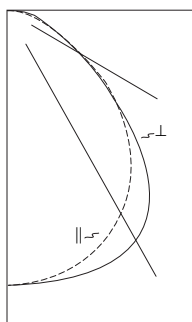
## CEILING COMPATIBILITY

G	G	G	F	MZ	Ceiling Type	Trim Type
Grid/Lay-in Standard	Concealed T	Slot Grid	Aluminum Flange Trim With Supporting Swing Gates	Modular Trim With Supporting Swing Gates	Exposed Grid	G
					Concealed T	G
					Slot Grid	G
					Flange	F
					Concealed "T" or "Z"	MZ
					Metal Pan	MZ
					(Verify compatibility/ consult Pre Sales Technical Support.)	

COOPER LIGHTING



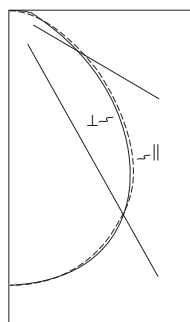
PHOTOMETRICS



**GC-132A**  
Electronic Ballast  
F32T8/35K Lamps  
2800 Lumens  
Spacing criterion:  
(||) 1.2 x mounting  
height, (⊥) 1.4 x  
mounting height  
Efficiency 67.9%  
Test Report:  
GC132A.IES  
LER = FL-54  
Yearly Cost of 1000  
lumens, 3000 hrs  
at .08 KWH = \$4.44

**Candela**

Angle	Along	45°	Across ⊥
0	766	766	766
5	762	766	767
10	752	763	769
15	737	755	770
20	714	742	767
25	681	723	756
30	637	694	730
35	583	649	680
40	520	578	590
45	441	491	472
50	351	386	361
55	277	280	269
60	215	192	195
65	160	127	146
70	117	86	118
75	89	73	99
80	67	62	75
85	36	34	39
90	0	0	0



**GC-232A**  
Electronic Ballast  
F32T8/35K Lamps  
2800 Lumens  
Spacing criterion:  
(||) 1.2 x mounting  
height, (⊥) 1.2 x  
mounting height  
Efficiency 64.2%  
Test Report:  
GC232A.IES  
LER = FL-56  
Yearly Cost of 1000  
lumens, 3000 hrs at  
.08 KWH = \$4.29

**Candela**

Angle	Along	45°	Across ⊥
0	1567	1567	1567
5	1555	1564	1565
10	1535	1549	1553
15	1502	1519	1526
20	1451	1472	1483
25	1381	1405	1414
30	1287	1313	1310
35	1172	1193	1181
40	1036	1045	1028
45	872	868	858
50	692	698	667
55	538	516	489
60	407	351	358
65	300	235	272
70	220	161	220
75	169	135	184
80	127	115	139
85	69	64	73
90	0	0	0

Coefficients of Utilization

rc rw RCR	Effective floor cavity reflectance 20%																	
	80%			70%			50%			30%			10%			0%		
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	81	81	81	81	79	79	79	79	75	75	75	72	72	72	69	69	69	68
1	75	72	70	67	73	71	68	66	68	66	64	65	64	62	63	61	60	59
2	69	64	60	57	68	63	59	56	61	58	55	59	56	54	57	55	53	51
3	64	58	53	49	62	57	52	49	55	51	48	53	50	47	51	49	46	45
4	59	52	47	43	58	51	46	42	49	45	42	48	44	41	47	43	41	39
5	54	47	41	37	53	46	41	37	44	40	36	43	39	36	42	38	36	34
6	50	42	36	32	49	41	36	32	40	36	32	39	35	32	38	34	32	30
7	47	38	32	29	45	37	32	28	36	32	28	36	31	28	35	31	28	27
8	43	34	29	25	42	34	28	25	33	28	25	32	28	25	31	27	24	23
9	40	31	25	22	39	30	25	22	30	25	21	29	24	21	28	24	21	20
10	37	28	23	19	36	28	23	19	27	22	19	26	22	19	26	22	19	18

Coefficients of Utilization

rc rw RCR	Effective floor cavity reflectance 20%																	
	80%			70%			50%			30%			10%			0%		
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
0	76	76	76	76	75	75	75	75	71	71	71	68	68	68	65	65	65	64
1	71	68	66	64	69	67	65	63	64	62	61	62	60	59	59	58	57	56
2	66	61	57	54	64	60	56	53	58	55	52	56	53	51	54	52	50	49
3	61	55	50	47	59	54	50	46	52	48	46	50	47	45	49	46	44	43
4	56	49	44	41	55	49	44	40	47	43	40	46	42	39	44	41	39	38
5	52	44	39	35	50	44	39	35	42	38	35	41	37	34	40	37	34	33
6	48	40	35	31	47	40	35	31	38	34	31	37	33	30	36	33	30	29
7	44	36	31	27	43	36	31	27	35	30	27	34	30	27	33	30	27	26
8	41	33	28	24	40	32	27	24	32	27	24	31	27	24	30	26	24	22
9	38	30	24	21	37	29	24	21	28	24	21	28	24	21	27	23	21	19
10	35	27	22	19	34	27	22	19	26	22	19	25	21	18	25	21	18	17

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixture
0-30	619	22.1	32.6
0-40	1018	36.3	53.6
0-60	1629	58.2	85.7
0-90	1900	67.9	100.0
0-180	1900	67.9	100.0

Typical VCP Percentages

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	75	79	74	79
30 x 30	69	73	68	72
30 x 60	60	64	58	62
60 x 30	70	74	69	74
60 x 60	60	63	58	62

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixture
0-30	1223	21.8	34.0
0-40	1962	35.0	54.6
0-60	3089	55.2	85.9
0-90	3594	64.2	100.0
0-180	3594	64.2	100.0

Typical VCP Percentages

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	62	67	62	67
30 x 30	54	59	53	58
30 x 60	44	48	42	46
60 x 30	56	61	55	60
60 x 60	45	48	43	47

ORDERING INFORMATION

SAMPLE NUMBER: GC-132A-UNV-EB81-U

<p><b>Rating</b> Blank=Standard NV=New York City Rated ATW-SW4=Chicago Rated</p> <p><b>Width</b> Blank=1' Width</p> <p><b>Trim Type</b> G=Grid/Lay-in – Standard<sup>(1)</sup> G=Concealed T G=Slot Grid F=Aluminum Flange Trim<sup>(5)</sup> MZ=Modular Trim EMZ=Modular Trim (Extended Swing Arm)</p> <p><b>Series</b> C=Specification Deep Troffer</p> <p><b>Doorframes</b> Standard=Flat White Steel Door (Leave Blank) FA=Flush White Extruded Aluminum c/w Spring Latch RA=Regressed White Extruded Aluminum (3/8") FAN=Flush Natural Anodized Extruded Aluminum RAN=Regressed Natural Anodized Extruded Aluminum (3/8") FAB=Flush Black Extruded Aluminum RAB=Regressed Black Extruded Aluminum (3/8")</p>	<p><b>Number of Lamps<sup>(2)</sup></b> 1, 2 or 3 lamps</p> <p><b>Wattage (Length)</b> 28T8=28W T8 (48") 32=32WT8 (48")</p> <p><b>Shielding</b> A=#12 Pattern Acrylic A125=#12 Pattern Acrylic (.125" Thickness) A19/156=#19 Pattern Acrylic (.156" Thickness) DA=Dropped Dish Matte White Acrylic IMA48=Injection Molded Acrylic (.150" Thickness) PB1S=1/2" x 1/2" x 1/2" Silver Parabolic Louver (Styrene)</p> <p><b>Option – Aluminum Flange Trim<sup>(5)</sup></b> Blank=SW (Single White) Type Color 'S' Single 'N' Natural 'R' In Row 'W' White 'E' End of Row</p>	<p><b>Voltage<sup>(3)</sup></b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal Voltage 120-277<sup>(4)</sup></p> <p><b>Options</b> GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed (Reference Flex ordering information) EL=Emergency Installed</p> <p><b>Lamps Installed</b> Blank=No Lamps Installed L8835=T8 Lamp, 28W and 32W, 3500K<sup>(6)</sup> L8841=T8 Lamp, 28W and 32W, 4100K<sup>(6)</sup> L8835HL=T8 Lamp, 32W, 3500K, 3100 Lumens L8841HL=T8 Lamp, 32W, 4100K, 3100 Lumens</p>	<p><b>Ballast Type<sup>(3)</sup></b> EB8 =T8 Electronic Instant Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2 EB8 /PLUS=T8 Electronic Instant Start. High Ballast Factor &gt;1.13. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2 ER8 =T8 Electronic Program Rapid Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1 or 2 HPT8 Ballast HB8_L=T8 Electronic Instant Start. Low Ballast Factor .77 HB8 =T8 Electronic Instant Start. Ballast Factor .88 HB8_N=T8 Electronic Instant Start. Normal Ballast Factor 1.0 HB8_H=T8 Electronic Instant Start. High Ballast Factor 1.15-1.2 HR8_DIM=T8 Electronic Program Start Step Dimming. Ballast Factor .88 HR8_L=T8 Electronic Program Start. Low Ballast Factor .77 HR8 =T8 Electronic Program Start. Ballast Factor .88 HR8_H=T8 Electronic Program Start. High Ballast Factor 1.15-1.2</p>	<p><b>Options</b> PAF=Painted After Fabrication RIF1=Radio Interference Suppressor 20GA/REP=20 Gauge Riveted Endplates. For use in New York City. RLS=Rotor-Lock Socket (T8 Lamps Only) (See options &amp; accessories)</p>	<p><b>Packaging</b> U=Unit Pack PAL=Job Pack, out of carton PALC=Job Pack, in carton</p>
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ACCESSORIES

EQ-CLIP-U=T-BAR Safety Earthquake Clips<sup>(1)</sup>

SHIPPING INFORMATION

Catalog No.	Wt.
GC-132A	19 lbs.
GC-232A	19 lbs.
GC-332A	19 lbs.

NOTES: <sup>(1)</sup>An EQ Grid Clip is recommended for all 9/16" ceiling systems. Four required per fixture. <sup>(2)</sup>Standard off-center ballast compartment on 3-lamp fixtures. <sup>(3)</sup>Products also available in non-US voltages and frequencies for international markets. <sup>(4)</sup>Not available when specifying emergencies, voltage must be specific. <sup>(5)</sup>Specify row configuration, type in catalog number when ordering complete fixture. <sup>(6)</sup>When utilizing 28W T8 lamps, HPT8 Ballast must be specified.

For complete product data, reference the Fluorescent Specification binder. Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.

Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)

**DESCRIPTION**

The Class R2 is a shallow recessed direct-indirect luminaire designed not only for shallow plenum applications, but now for plenum-less applications as well. The universal surface mount kit, ideal for retrofit and remodel projects where a recessed aesthetic is preferred but plenum space is not available, can be used in combination with any of the Class R2 media options. The snap-together design of the frame allows for easy installation while the fixture's T5 specific design delivers highly efficient illumination for both task lighting and luminous vertical wall surfaces.

<b>Catalog #</b>		<b>Type</b>	
<b>Project</b>		<b>A7</b>	
<b>Comments</b>		<b>Date</b>	
<b>Prepared by</b>			

**SPECIFICATION FEATURES**

**A ... Construction**

Fixture housing constructed of die-formed 20 gauge cold rolled steel with integral one-piece 20 gauge gear tray.

Surface mounting kit with snap-together frame design constructed of die-formed 20 gauge cold rolled steel.

**B ... Reflectors**

High reflectance white powder coat painted reflector system.

**C ... Shielding**

Linear prismatic co-extruded acrylic lens with fully frosted center and clear/frost blended lens returns. Lens is designed to provide low glare ambient illumination while creating evenly luminous side reflectors. Lens secured to housing via injection molded inserts for easy lamp access.

**D ... Electrical**

T5/T5HO fixtures are pre-wired with quick wire connectors and use UL listed Class P, T5/T5HO program rapid start universal voltage electronic ballasts, power factor of 97% with less than 10% THD. Fixtures and electrical components certified to UL and CUL standards.

**E ... Finish**

Fixture housings and surface mounting kits are standard white using electrostatically applied polyester powder coat paint.

**Mounting**

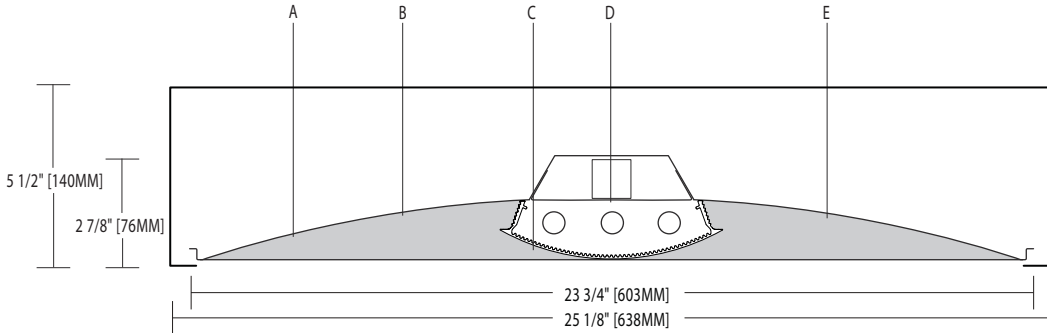
Surface mounting kit installs easily with four (4) 1/4-20 screws. Frame mounts first onto surface, by others. Fixture housing slides into open end of frame and remaining frame piece snaps into place for seamless finish. See installation instructions for further detail.



**CLASS R2  
SURFACE  
Lensed**

3T5  
3T5HO

**2'x4' Surface Mount**  
2-7/8" Fixture Depth  
5-1/2" Mounting Kit Depth



**ORDERING INFORMATION**

Sample Number: R2-WL-3T5-1C-UNV-24-SU

<b>Series</b> R2: Class R2 Surface	<b>Shielding</b> L: Linear Prismatic Lens	<b>Lamp Type</b> N5: T5 Normal Output T5: T5 High Output	<b>Wiring</b> <sup>1</sup> B: Battery Pack C: Standard Circuit D: Dimming / Step Dimming E: Emergency T: Nightlight Y: Daylight	<b>Voltage</b> <sup>1</sup> 120: 120V 277: 277V 347: 347V UNV: Universal (120V-277V)	<b>Size</b> 24: 2' x 4'	<b>Ceiling Type</b> SU: Surface Mount	<b>Options</b> <sup>1</sup> LG: Lens Gasketing SD: Step Dimming
<b>Reflector</b> W: White	<b>Number of Lamps</b> 3: 3 Lamps	<b>Number of Circuits</b> <sup>1</sup> 1: 1 Circuit 2: 2 Circuits					

Notes: 1 Not all options available. Please consult your Cooper Lighting Representative for availability. Specifications and dimensions subject to change without notice.

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The M Series combines a low profile, surface modular design with the latest in energy-efficient technology. The dihedral recessed top design allows for cooler fixture operation. Other features include a die-formed housing, surface or stem mounting (single or continuous row), full seam - welded corners and a broad selection of attractive door frames.

The versatile modular M Series can be the perfect solution when used in applications such as commercial office spaces, schools, hospitals, and retail merchandising.

Catalog #		Type	A8
Project		Date	
Comments			
Prepared by			

## SPECIFICATION FEATURES

### A ... Construction

Housing die formed code gauge prime cold rolled steel. Smooth sides permit flush joint for continuous row mounting. Full seam welded corners. Dihedral recessed top design insures cooler ballast operation. Die formed captive lampholder bracket fully encloses wiring permitting easy lampholder replacement. Ballast covers easily removed without tools.

### B ... Electrical\*

Ballasts are CBM/ETL Class "P" and are positively secured by mounting bolts. Pressure lock lampholders. UL/CUL listed. Suitable for damp locations.

### C ... Finish

Painted after fabrication. Electrostatically applied baked white polyester powder enamel finish. Multistage cleaning cycle, iron phosphate coating with rust inhibitor. Conveyorized application and baking timing accurately controlled at an elevated temperature.

### D ... Hinging/Latching

Positive cam action steel latches with baked white enamel finish. Safety lock T-hinges allow hinging and latching either side.

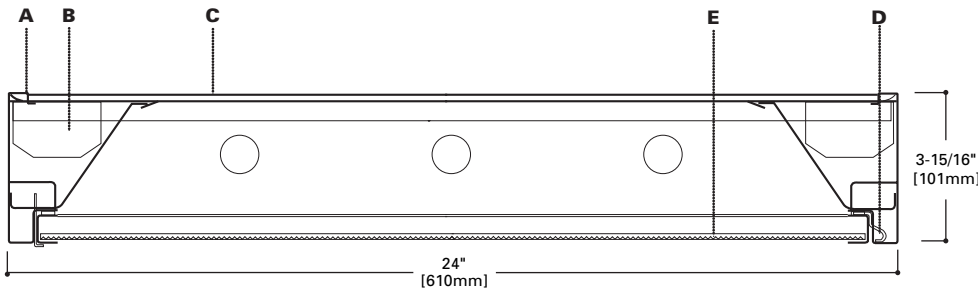
### E ... Frame/Shielding

Die formed, heavy gauge, flat steel door. Baked white enamel finish. Reinforced, mitered door frame corners. Door frame quadrasealed to prevent light spillage. Light stabilized 100% virgin acrylic prismatic shielding. Standard #12 pattern. Optional shielding available.

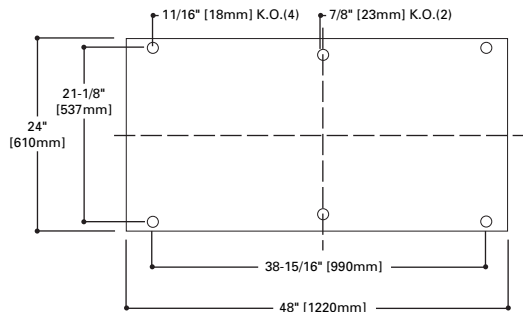


**2M  
340  
332**

**2' X 4' SURFACE  
3 LAMPS  
Surface Modular**



## MOUNTING DATA

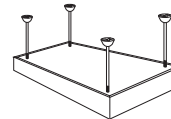


## STEM MOUNTING METHODS

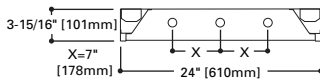
Consult Pre Sales Technical Support for Continuous Row Application

### Fixture Application

4 Point Suspension



## LAMP CONFIGURATIONS



## DOOR FRAMES

2M  
Flat, White  
Steel



2MXF  
Flat, Extruded  
White Aluminum



2MSR  
Regressed  
White Steel



2MXR  
Regressed,  
Natural Aluminum



2MXRD  
Deep, Regressed,  
Extruded Natural Aluminum



## ENERGY DATA

Input Watts:

**EB Ballast & STD Lamps**

340 (110)

332 (91)

**ES Ballast & STD Lamps**

340 (136)

332 (108)

Luminaire Efficacy Rating

**LER = FL-76**

**Catalog Number: 2M-332A**

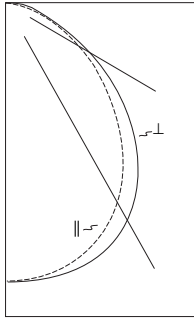
**Yearly Cost of 1000 lumens,  
3000 hrs at .08 KWH = \$3.16**

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

**LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS**

**LINEAR DISCONNECT**  
Safe and convenient means of disconnecting power





**2M-332A**

Energy Saving Ballast

F032T8/35K Lamps  
2850 Lumens

Spacing criterion:  
(H) 1.2 x mounting height, (L) 1.3 x mounting height  
Efficiency 84.8%

Test Report:  
2M332A.IES

LER = FL-76

Yearly Cost of 1000 lumens, 3000 hrs at .08 KWH = \$3.16

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																	
	80%			70%			50%			30%			10%			0%		
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																		
0	101	101	101	101	99	99	99	99	94	94	94	90	90	90	87	87	87	85
1	93	90	87	84	91	88	85	82	84	82	80	81	79	77	78	76	75	73
2	86	80	75	70	84	78	74	70	75	71	68	73	69	66	70	67	65	63
3	79	71	65	60	77	70	64	60	68	63	59	65	61	58	63	60	57	55
4	73	64	57	52	71	63	57	52	61	55	51	59	54	50	57	53	50	48
5	67	57	50	45	66	56	50	45	54	49	44	53	48	44	51	47	43	42
6	62	52	44	39	61	51	44	39	49	43	39	48	43	38	47	42	38	36
7	57	47	39	34	56	46	39	34	45	38	34	43	38	34	42	37	34	32
8	53	42	35	30	52	41	35	30	40	34	30	39	34	30	38	33	29	28
9	49	38	31	26	48	37	31	26	36	30	26	35	30	26	34	29	26	24
10	45	34	28	23	44	34	27	23	33	27	23	32	27	23	31	26	23	21

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	2286	26.7	31.5
0-40	3692	43.2	50.9
0-60	6083	71.1	83.9
0-90	7254	84.8	100.0
0-180	7254	84.8	100.0

**Typical VCP Percentages**

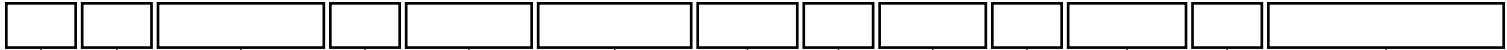
Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	61	67	59	64
30 x 30	54	59	53	57
30 x 60	45	48	44	47
60 x 30	56	61	56	60
60 x 60	46	49	45	48

**Candela**

Angle	Along H	45°	Across L
0	2915	2915	2915
5	2900	2907	2919
10	2854	2878	2903
15	2782	2827	2873
20	2676	2747	2816
25	2536	2625	2724
30	2353	2455	2588
35	2122	2243	2387
40	1859	2003	2139
45	1593	1748	1863
50	1334	1474	1575
55	1082	1178	1286
60	849	870	995
65	653	589	736
70	501	400	544
75	384	313	407
80	270	237	290
85	149	135	161
90	0	0	0

**ORDERING INFORMATION**

Sample Number: 2M-332A-120V-EB81-U



**Width**  
2=2' Width

**Series** 1, 2  
M=1' Width (3 Lamp), 2' Width

**Door Frame**  
Standard=Flat White Steel Door (Leave blank)

**FA**=Flush White Extruded Aluminum c/w Spring Latch

**RA**=Regressed White Extruded Aluminum

**FAN**=Flush Natural Anodized Extruded Aluminum

**RAN**=Regressed Natural Anodized Extruded Aluminum

**FAB**=Flush Black Extruded Aluminum

**RAB**=Regressed Black Extruded Aluminum

**Number of Lamps** 3  
2 Lamps (Not Included)  
3 Lamps (Not Included)  
4 Lamps (Not Included)

**Wattage**  
U6T8=31W T8 (24")  
U6=40W T12 (24")  
U0=20W T12 (24")  
17=17W T8 (24")  
U15/8=31W T8 (24")  
32=32W T8 (48")  
40=40W T12 (48")  
BX40=40W Biax (24")

**Lens**  
A=#12 Pattern Acrylic (Standard)  
A125=#12 Pattern Acrylic (.125" Thick)  
A19/156=#19 Pattern Acrylic (.156" Thick)

**Voltage** 4  
120V=120 Volt  
277V=277 Volt  
347V=347 Volt  
UNV=Universal Voltage<sup>5</sup> 120-277

**Options**  
GL=Single Element Fuse  
GM=Double Element Fuse  
EL=Emergency Installed

**Ballast Type** 4  
Blank=Standard Magnetic T12 Ballast  
Blank=Standard Magnetic Biax Ballast  
EB=Electronic Instant Start  
ER=T8 Electronic Program Rapid Start. Total Harmonic Distortion < 10%  
DLS=Digital Lighting System Dimming

**Lamp Size**  
2=T12  
5=T5 Biax  
8=T8

**Number of Ballasts**  
1= 1 Ballast  
2= 2 Ballast

**Options**  
PLUS=Higher Ballast Factor > 1.13. Total Harmonic Distortion < 20%  
RLS=Rotor Lock Socket (T8 Lamp only)  
RIF1=Radio Interference Suppressor  
VRS=Vandal Resistant<sup>6</sup> Screws  
EKO=End plate with 7/8" KO<sup>7</sup> (Required for Continuous Row Mounting)

**Packaging**  
U=Unit Pack

- Notes:**
- 2' x 2', 2' x 4' require 4-point suspension, side mounted.
  - Full seam welded corners on 1' x 4', 2' x 4'.
  - 1' x 4' 3-lamp, 2' x 4' 3-lamp.
  - Products also available in non-US voltages and frequencies for international markets.
  - Not Available when specifying emergency, voltage must be specific.
  - Available on flat doors only.
  - For continuous row mounting 7/8" KOs furnished in end of fixture, specify EKO.

**SHIPPING INFORMATION**

Catalog No.	Wt.
2M-332A	36 lbs.

**ACCESSORIES**

(Order Separately)  
SCF=Fixed Stem Set (Specify Length)  
SCS=Swivel Stem Set (Specify Length)  
SCA=Adjustable 48" Stem Set  
  
(Additional Accessories Available. See Options and Accessories Section.)

**NO WIRING  
NO ELECTRICITY  
NO BATTERIES  
NO MAINTENANCE**



**SRB EXIT SIGNS**

**ALWAYS ON .... ALWAYS WORKING**

- *No Wiring*
- *No Electricity*
- *No Batteries*
- *No Maintenance*
- 



**ISO 9001**

**SRB TECHNOLOGIES INC.**

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Toll Free: 1-800-552-0098

E-Mail: [sales@srbtechnologies.com](mailto:sales@srbtechnologies.com)

Web: [WWW.SRBTECHNOLOGIES.COM](http://WWW.SRBTECHNOLOGIES.COM)





# BETALUX® (BX) FEATURES

- VANDAL RESISTANT
- OPERATING TEMPERATURE - 76°F TO +212°F
- EXPLOSION PROOF
- WATERPROOF
- REQUIRES NO WIRING
- FIELD SELECTABLE DIRECTION ARROWS
- INSTALLS IN MINUTES
- SUITABLE FOR CLEAN ROOM APPLICATIONS
- NO BULB TO FAIL OR REPLACE
- CORROSION RESISTANT
- FAIL SAFE
- RECYCLABLE IF RETURNED TO MANUFACTURER
- LIGHTWEIGHT
- 10, 15 OR 20 YEAR LIFE
- TOTALLY SELF POWERED

# TYPICAL APPLICATIONS

AOR



\* NO ELECTRICITY

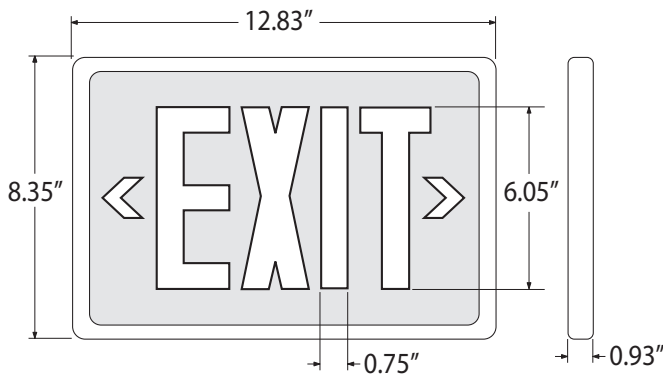
\* NO BATTERIES

\* ALWAYS ON

\* SELF-POWERED

\*NO MAINTENANCE

# SPECIFICATIONS



### ILLUMINATION SOURCE

- Borosilicate (hard) glass
- Internally coated with phosphorescent powder
- Filled with Tritium gas

### BRIGHTNESS

- Minimum brightness at time of manufacture of 0.15 foot lamberts.

### CONSTRUCTION

- Encased in high-impact, fire-retardant ABS plastic

### COMPLIES WITH:

- NFPA Life Safety Code 101
- U.L. 924
- City of Los Angeles
- State of California
- Council of American Building Officials (ICBO, SBCCI)
- OSHA
- USNRC
- ISO 9001

\* NO ELECTRICITY

\* NO BATTERIES

\* ALWAYS ON

\* SELF-POWERED

\*NO MAINTENANCE

# ORDERING INFORMATION

MODEL	LIFE IN YEARS	FRAME COLOUR	FACES	LEGEND COLOUR	ACCESSORIES
BX	10 - 10 Years	GY - Gray	S - Single	RD - Red	WG - Wire Guard
	15 - 15 Years	BK - Black	D - Double	GN - Green	AF - Aluminum Frame
	20 - 20 Years	WH - White			PC - Polycarbonate Window
					PM - Pendant Mount
					SC - Security Cover

ORDERING EXAMPLE: BX-10-BK-S-RD = BX, 10 Year, Black Frame, Single Face Sign with Red Legend

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The Ovation Series is a complete family of recessed direct/indirect luminaires featuring pleasant modern architectural styling, computer-designed optics and the latest energy efficient lamp and ballast technology. The luminaire combines a matte white indirect reflector and two perforated direct lamp shields to provide optimum brightness control. All components are located above the ceiling plane for a clean architectural appearance in the finished space. Carefully balanced design elements combine to provide an efficient and exciting, high performance alternative to traditional general lighting. Ovation is an excellent choice for a wide variety of commercial applications.

## SPECIFICATION FEATURES

### A ... Construction

Nominal 6" deep housing is die formed of code gauge, prime cold rolled steel. Heavy gauge end plates are securely attached with screws for strength and rigidity and the elimination of gaps. Four auxiliary fixture end suspension points are provided. KOs for continuous row wiring. Large access plate for supply connection.

### B ... Electrical\*

Ballasts are Class "P" and are positively secured. Rotor-lock lampholders ensure positive lamp

retention. UL/CUL listed. Suitable for damp locations.

### C ... Ballast Access

Ballast can be removed from below the ceiling.

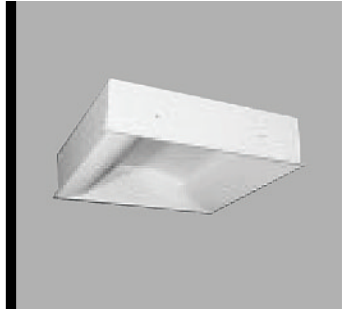
### D ... Finish

Durable cold rolled steel with multistage, iron phosphate pretreatment and white enamel finish to ensure maximum bonding and rust inhibition.

### E ... Reflectors

Indirect reflector has high reflectance baked matte white enamel finish for luminous uniformity. A pair of positively retained direct lamp shields constructed of heavy gauge perforated steel with high reflectance painted after fabrication finish and milky white overlay diffuser for visual comfort. All reflectors are precision formed in a computer-controlled operation.

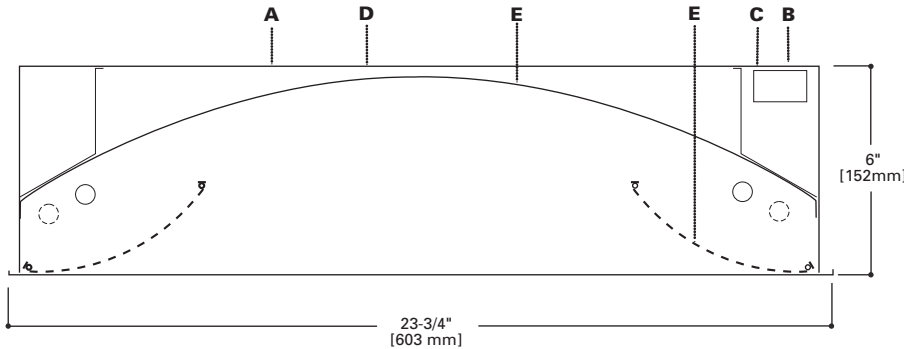
Catalog #		Type
Project		B
Comments		Date
Prepared by		



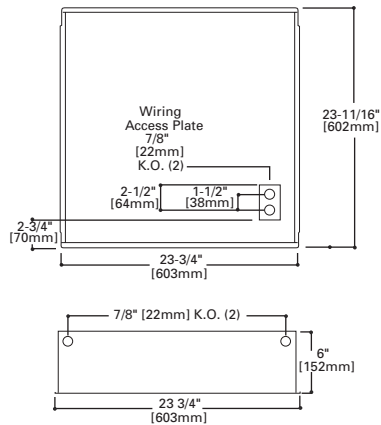
**2RDI-**  
**S-214T5**  
**S-414T5**  
**S-224T5HO**  
**S-424T5HO**

**T5 OR T5HO LAMPS**  
**2' X 2' Recessed**  
**Direct/Indirect**  
**Side-Mount**

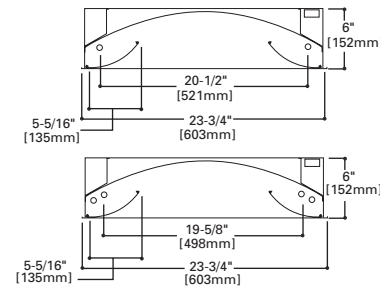
*Ovation*  
 15



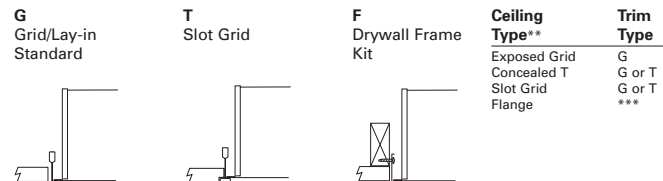
## MOUNTING DATA



## LAMP CONFIGURATIONS



## CEILING COMPATIBILITY



## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
 214T5 (38)  
 414T5 (76)  
 224T5 (52)  
 424T5 (104)  
 Luminaire Efficacy Rating  
**LER = FL49**  
 Catalog Number: 2RDI-S-214T5RP  
 Yearly Cost of 1000 lumens,  
 3000 hrs at .08 KWH = \$4.90

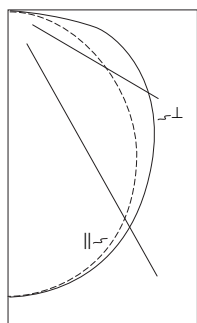
\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

\*\*Consult Pre Sales Technical Support.  
 \*\*\*See Drywall Frame Kit Accessory

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**  
 Safe and convenient means of disconnecting power





**2RDI-S-214T5RP**  
 Electronic Ballast  
 F14/T5/835 Lamps  
 1350 Lumens  
 Spacing criterion:  
 (||) 1.2 x mounting height,  
 (⊥) 1.3 x mounting height  
 Efficiency 64.8%  
 Test Report  
 2RDIS214T5RP.IES  
 LER = FL49  
 Yearly Cost of 1000 lumens,  
 3000 hrs at .08 KWH = \$4.90

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																	
	80%			70%			50%			30%			10%			0%		
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																		
0	77	77	77	77	75	75	75	75	72	72	72	69	69	69	66	66	66	65
1	71	68	65	63	69	66	64	62	63	61	60	61	59	58	59	57	56	55
2	64	59	55	51	63	58	54	50	56	52	49	53	51	48	51	49	47	46
3	59	52	47	43	57	51	46	42	49	45	42	47	44	41	46	43	40	39
4	54	46	41	36	52	45	40	36	44	39	35	42	38	35	41	37	35	33
5	49	41	35	31	48	40	34	30	39	34	30	37	33	30	36	32	29	28
6	45	36	31	26	44	37	30	26	35	30	26	34	29	26	33	29	25	24
7	42	33	27	23	40	32	27	23	31	26	23	30	26	22	29	25	22	21
8	38	29	24	20	37	29	23	20	28	23	20	27	23	19	26	22	19	18
9	35	26	21	17	34	26	21	17	25	20	17	24	20	17	24	20	17	15
10	33	24	19	15	32	24	18	15	23	18	15	22	18	15	22	18	15	14

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	455	16.9	26.0
0-40	746	27.6	42.6
0-60	1329	49.2	75.9
0-90	1750	64.8	100.0
0-180	1750	64.8	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	70	76	59	68
30 x 30	65	68	53	57
30 x 60	64	66	48	49
60 x 30	65	68	58	62
60 x 60	64	64	52	52

**Candela**

Angle	Along	45°	Across ⊥
0	582	582	582
5	581	580	583
10	573	575	577
15	559	562	566
20	539	544	549
25	514	522	530
30	484	494	506
35	449	464	478
40	409	429	449
45	366	390	420
50	319	351	390
55	268	312	359
60	218	272	328
65	169	233	298
70	125	192	263
75	86	146	216
80	46	89	130
85	16	29	46
90	0	0	0

**ORDERING INFORMATION**

Sample Number: 2RDI-S-214T5RP-120V-EBT1-U

<b>Width</b> 2=2' Width	<b>Number of Lamps</b> 2=2 Lamps 4=4 Lamps	<b>Lamp Shield</b> X=Solid Matte White RP=Round Perforated White Steel	<b>Ballast Type <sup>2</sup></b> EB=Electronic Instant Start DLS=Digital Lighting System Dimming	<b>Options</b> RIF1=Radio Interference Suppressor REP=Riveted End Plates LSC=Lamp Shield Cable ST=Semi-Specular Tannenbaum	<b>Packaging</b> U=Unit Pack PALC=Palletized Fixtures in Carton
<b>Series</b> RDI=Ovation Series (Recessed Direct/Indirect)	<b>Wattage</b> 14T5=14W T5 (24") <sup>1</sup> 24T5=24W T5HO (24") <sup>1</sup>	<b>Voltage <sup>2</sup></b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal 120/277 Voltage	<b>Lamp Size</b> T=T5 Linear		
<b>Trim Type</b> Blank=Grid/Lay-in (Standard)		<b>Options</b> Lamps=Lamps Installed GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed EL=Emergency Installed	<b>Number of Ballasts</b> 1=1 Ballast 2=2 Ballast 3=3 Ballast		
<b>Lamp Position</b> S=Side Mount					

Notes: 1 2' x 2' and 2' x 4' Center Lamp Shield model only.  
 2 Products also available in non-US voltage and frequencies for international markets

**ACCESSORIES**

EQ = T-BAR Safety Earthquake Clips (Use Four Per Fixture)  
 DF-22-W = Drywall Frame Kit

**SHIPPING INFORMATION**

Catalog No.	Wt.
2RDI-S-214T5	15.5 lbs.
2RDI-S-414T5	15.5 lbs.
2RDI-S-224T5	15.5 lbs.
2RDI-S-424T5	15.5 lbs.



# COOPER LIGHTING - METALUX®

## DESCRIPTION

The GC Series features a 4-3/4" deep para-contoured fixture housing, high reflectivity and optimum lamp to lens spacing. The series produces total uniformity of light in the luminous area and is compatible with all of today's popular ceiling systems and is available with a number of options and accessories for application versatility.

The specification luminaire is designed to offer maximum efficiency and performance for today's unique interior specifications. The GC Series is an excellent choice for commercial office spaces, schools, hospitals or retail merchandising areas.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

## SPECIFICATION FEATURES

### A... Construction

Nominal 4-3/4" deep, para-contoured housing, die formed, prime cold rolled steel. Die embossed housing has full length die formed stiffeners for added strength. Deep "V" ballast/wireway cover easily removed without tools. Die formed captive lampholder bracket fully encloses lampholder wiring permitting easy lampholder replacement. Heavy endplates are securely attached with interlocking tabs and screws. Four auxiliary fixture end suspension points provided. KOs for continuous row wiring. Endplates have integral Grid-Lock feature for safety and convenience.

### B... Electrical

Ballasts are CBM/ETL Class "P" and are positively secured. 2G11 base lampholders have double-edge wiping action pressure lock contacts with horizontally oriented lamp support clips. UL/CUL listed. Suitable for damp locations.\*\*

### C... Finish

Multistage, iron phosphate pre-treatment ensures maximum bonding and rust inhibitor. Lighting grade, baked white enamel finish.

### D... Hinging/Latching

Positive cam action spring loaded steel latches with baked white enamel finish. Safety-lock T-hinges allow hinging and latching either side.

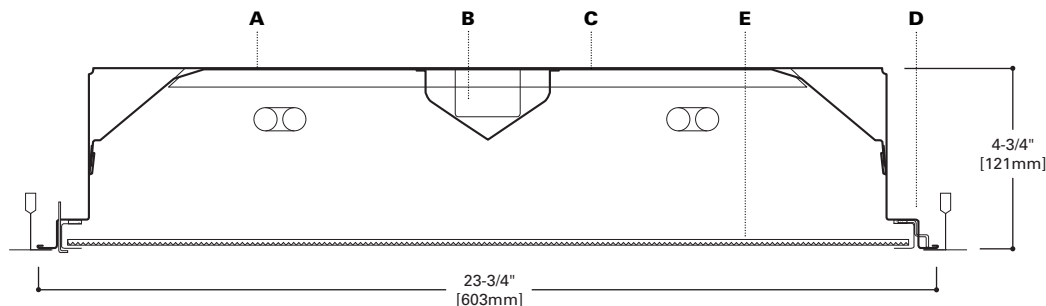
### E... Frame/Shielding

Die formed, heavy gauge, flat steel door with reinforced mitered corners and baked white enamel finish. Positive light seals. Light stabilized 100% virgin acrylic prismatic shielding. Standard #12 pattern. Optional shielding available.

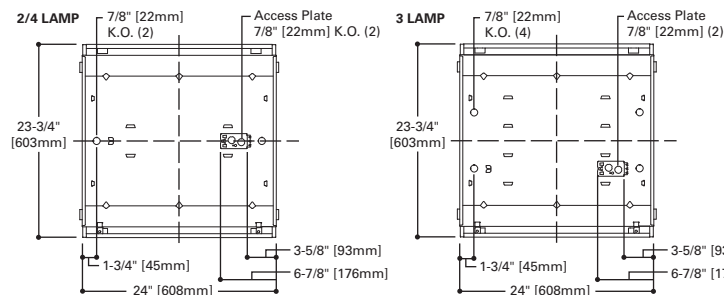


**2GC**  
**2BX40**  
**3BX40**  
**4BX40**

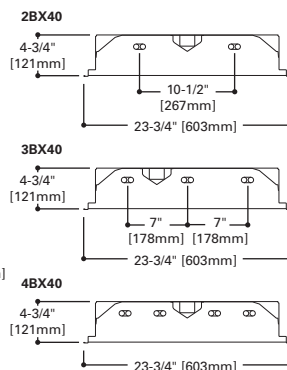
**2' X 2' TROFFER**  
**2, 3 OR 4 BIAxIAL LAMPS**  
Specification Deep Troffer



## MOUNTING DATA



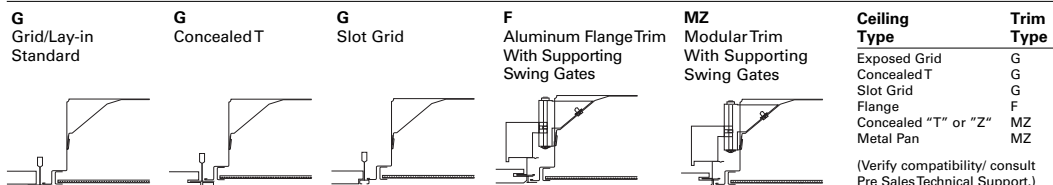
## LAMP CONFIGURATIONS



## DOOR FRAMES



## CEILING COMPATIBILITY



COOPER LIGHTING

## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
2BX40 (67), 3BX40 (110)

Luminaire Efficacy Rating  
**LER = FL-62**

**Catalog Number: 2GC-2BX40**

**Yearly Cost of 1000 lumens,**  
**3000 hrs at .08 KWH = \$3.87**

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

\*\*Consult Pre Sales Technical Support.

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

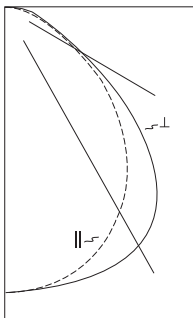
**LINEAR DISCONNECT**

Safe and convenient means of disconnecting power.



ADF090606

PHOTOMETRICS



**2GC-2BX40A**  
Electronic Ballast  
F40BX/SPX35/RS  
Lamps  
3150 Lumens

Spacing criterion:  
(II) 1.2 x mounting  
height, (L) 1.4 x  
mounting height

Efficiency 74.3%

Test Report:  
2GC2BX40A.IES  
LER = FL-62

Yearly Cost of 1000  
lumens, 3000 hrs at  
.08 KWH = \$3.87

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																				
	80%				70%				20%												
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0%
<b>RCR</b>																					
0	88	88	88	88	86	86	86	86	83	83	83	79	79	79	76	76	76	74			
1	82	79	76	74	80	77	75	73	74	72	70	71	70	68	69	67	66	65			
2	76	70	66	62	74	69	65	62	67	63	60	64	61	59	62	60	58	56			
3	70	63	58	54	68	62	57	53	60	56	52	58	54	52	56	53	51	49			
4	65	57	51	47	63	56	51	46	54	49	46	52	48	45	51	47	45	43			
5	60	51	45	40	58	50	44	40	49	44	40	47	43	39	46	42	39	37			
6	55	46	40	35	54	45	40	35	44	39	35	43	38	35	42	38	34	33			
7	51	42	35	31	50	41	35	31	40	35	31	39	34	31	38	34	30	29			
8	47	37	31	27	46	37	31	27	36	31	27	35	30	27	34	30	27	25			
9	43	34	28	24	42	33	27	24	32	27	23	32	27	23	31	26	23	22			
10	40	31	25	21	39	30	25	21	29	24	21	29	24	21	28	24	21	19			

**Zonal Lumen Summary**

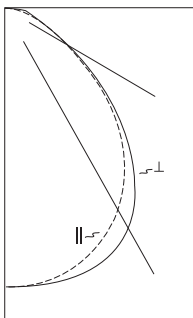
Zone	Lumens	%Lamp	%Fixture
0-30	1526	24.2	32.6
0-40	2492	39.6	53.2
0-60	4013	63.7	85.7
0-90	4682	74.3	100.0
0-180	4682	74.3	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	59	64	55	60
30 x 30	51	56	48	52
30 x 60	41	45	37	40
60 x 30	52	57	50	55
60 x 60	42	45	38	41

**Candela**

Angle	Along II	45°	Across L
0	1902	1902	1902
5	1896	1898	1911
10	1868	1884	1916
15	1812	1853	1911
20	1737	1806	1894
25	1641	1738	1852
30	1521	1640	1774
35	1375	1506	1659
40	1204	1331	1494
45	1007	1120	1269
50	795	906	999
55	618	678	744
60	479	472	526
65	368	322	383
70	273	222	301
75	202	175	248
80	154	146	190
85	86	79	104
90	0	0	0



**2GC-3BX40A**  
Electronic Ballast  
F40BX/SPX35/IS  
Lamps  
3150 Lumens

Spacing criterion:  
(II) 1.2 x mounting  
height, (L) 1.3 x  
mounting height

Efficiency 73.4%

Test Report:  
2GC3BX40A.IES  
LER = FL-61

Yearly Cost of 1000  
lumens, 3000 hrs at  
.08 KWH = \$3.93

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																				
	80%				70%				20%												
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0%
<b>RCR</b>																					
0	87	87	87	87	85	85	85	85	82	82	82	78	78	78	75	75	75	73			
1	81	78	75	73	79	76	74	72	73	71	70	70	69	67	68	67	65	64			
2	75	70	66	62	73	68	65	61	66	63	60	64	61	59	61	59	57	56			
3	69	63	58	54	68	62	57	53	60	56	52	58	54	51	56	53	50	49			
4	64	57	51	47	63	56	50	46	54	49	46	52	48	45	51	47	45	43			
5	59	51	45	40	58	50	44	40	48	44	40	47	43	39	46	42	39	38			
6	55	46	40	36	54	45	40	36	44	39	35	43	38	35	42	38	35	33			
7	51	42	36	31	50	41	35	31	40	35	31	39	34	31	38	34	31	29			
8	47	38	32	28	46	37	31	27	36	31	27	35	31	27	34	30	27	26			
9	43	34	28	24	42	33	28	24	33	27	24	32	27	24	31	27	24	22			
10	40	31	25	21	39	30	25	21	30	25	21	29	24	21	28	24	21	20			

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	2366	25.0	34.1
0-40	3805	40.3	54.9
0-60	5973	63.2	86.2
0-90	6932	73.4	100.0
0-180	6932	73.4	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	49	54	47	52
30 x 30	41	46	39	43
30 x 60	32	35	28	32
60 x 30	43	47	41	46
60 x 60	32	35	29	33

**Candela**

Angle	Along II	45°	Across L
0	2992	2992	2992
5	2994	2986	2999
10	2957	2968	2995
15	2884	2921	2971
20	2777	2843	2917
25	2632	2729	2812
30	2446	2558	2631
35	2211	2325	2374
40	1932	2032	2056
45	1613	1687	1711
50	1269	1332	1360
55	966	992	997
60	731	678	704
65	546	450	530
70	400	309	426
75	302	249	354
80	228	214	274
85	125	122	151
90	0	0	0

**ORDERING INFORMATION**

SAMPLE NUMBER: 2GC-2BX40A-120V-EB51-U

<p><b>Rating</b> Blank= Standard NY=New York City Rated ATW-SW4= Chicago Rated</p>	<p><b>Number of Lamps</b> 2=2 Lamps 3=3 Lamps<sup>(7)</sup> 4=4 Lamps<sup>(6)</sup></p>	<p><b>Ballast Type</b><sup>(2)</sup> (Also available in Rapid Start, must specify ballast number) EB5 = T5 Electronic Instant Start. Total Harmonic Distortion &lt; 20%</p>	<p><b>Options</b> RIF1=Radio Interference Suppressor 20GA/REP=20 Gauge Housing w/Riveted End Plate PAF=Painted After Fabrication LAO=Less Access Opening</p>
<p><b>Width</b> 2=2' Width</p>	<p><b>Wattage</b> BX40=40W Biax (24")</p>	<p>No. of Ballast 1 or 2</p>	<p><b>Packaging</b> U=Unit Pack PAL=Palletized Uncartoned Fixtures PALC=Palletized Fixtures in Carton</p>
<p><b>Trim Type</b> G=Grid/Lay-in (Standard)<sup>(1)</sup> G=Concealed T G=Slot Grid F=Aluminum Flange Trim<sup>(5)</sup> MZ=Modular Trim EMZ=Modular Trim (Extended Swing Arm)</p>	<p><b>Shielding</b> A=#12 Acrylic Pattern A125=#12 Pattern Acrylic (.125" Thickness) A19/156=#19 Pattern Acrylic (.156" Thickness) DA=Dropped Dish Matte White Acrylic IMA48=Injection Molded Acrylic (.150" Thickness) PB1S=1/2" x 1/2" x 1/2" Silver Parabolic Louver (Styrene)</p>	<p>TEB5 =T5 Biax Electronic Instant Start. Total Harmonic Distortion &lt; 10%</p> <p>No. of Ballast 1, 2 or 3</p>	<p><b>ACCESSORIES</b> EQ-CLIP-U=T-BAR Safety Earthquake Clips<sup>(1)</sup></p>
<p><b>Series</b> C=Specification Deep Troffer</p>	<p><b>Option - Aluminum Flange Trim</b><sup>(5)</sup> Blank=SW (Single White) Type Color 'S' Single 'N' Natural 'R' In Row 'W' White 'E' End of Row</p>	<p><b>NOTES:</b> <sup>(1)</sup>An EQ Grid Clip is recommended for all 9/16" ceiling systems. Four required per fixture. <sup>(2)</sup>Products also available in non-US voltages and frequencies for international markets. <sup>(3)</sup>Not available when specifying emergencies, voltage must be specific. <sup>(4)</sup>Fixtures equipped with "EL" option may require a 5-1/2" housing depth. If installing in field, must use low profile battery pack. <sup>(5)</sup>Specify row configuration, type in catalog number when ordering complete fixture. <sup>(6)</sup>Less Access Opening (LAO) housing is required. <sup>(7)</sup>Standard off-center ballast compartment on 3-lamp fixtures.</p>	
<p><b>Door Frame</b> Standard=Flat White Steel Door (Leave Blank) FA=Flush White Extruded Aluminum c/w Spring Latch RA=Regressed White Extruded Aluminum (3/8") FAN=Flush Natural Anodized Extruded Aluminum RAN=Regressed Natural Anodized Extruded Aluminum (3/8") FAB=Flush Black Extruded Aluminum RAB=Regressed Black Extruded Aluminum (3/8")</p>	<p><b>Voltage</b><sup>(2)</sup> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal Voltage 120-277<sup>(3)</sup></p>	<p>For complete product data, reference the Fluorescent Specification binder. Specifications &amp; dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.</p>	
<p><b>Options</b> GL=Single Element Fuse GM=Double Element Fuse Lamps=Lamps Installed (refer to lamp ordering options) Flex=Flex Installed (Reference Flex ordering information) EL=Emergency Installed<sup>(4)</sup></p>			

**SHIPPING INFORMATION**

Catalog No.	Wt.
2GC-2BX40A	18 lbs.
2GC-3BX40A	18 lbs.
2GC-4BX40A	18 lbs.



# COOPER LIGHTING - METALUX®

## DESCRIPTION

The Ovation Series is a complete family of recessed direct/indirect luminaires featuring pleasant modern architectural styling, computer-designed optics and the latest energy efficient lamp and ballast technology. The luminaire combines a matte white indirect reflector and two perforated direct lamp shields to provide optimum brightness control. All components are located above the ceiling plane for a clean architectural appearance in the finished space. Carefully balanced design elements combine to provide an efficient and exciting, high performance alternative to traditional general lighting. Ovation is an excellent choice for a wide variety of commercial applications.

## SPECIFICATION FEATURES

### A ... Construction

Nominal 6" deep housing is die formed of code gauge, prime cold rolled steel. Heavy gauge end plates are securely attached with screws for strength and rigidity and the elimination of gaps. Four auxiliary fixture end suspension points are provided. KOs for continuous row wiring. Large access plate for supply connection.

### B ... Electrical\*

Ballasts are Class "P" and are positively secured. Rotor-lock lampholders ensure positive lamp retention. UL/CUL listed. Suitable for damp locations.

### C ... Ballast Access

Ballast can be removed from below the ceiling.

### D ... Finish

Durable cold rolled steel with multistage, iron phosphate pretreatment and white enamel finish to ensure maximum bonding and rust inhibition.

### E ... Reflectors

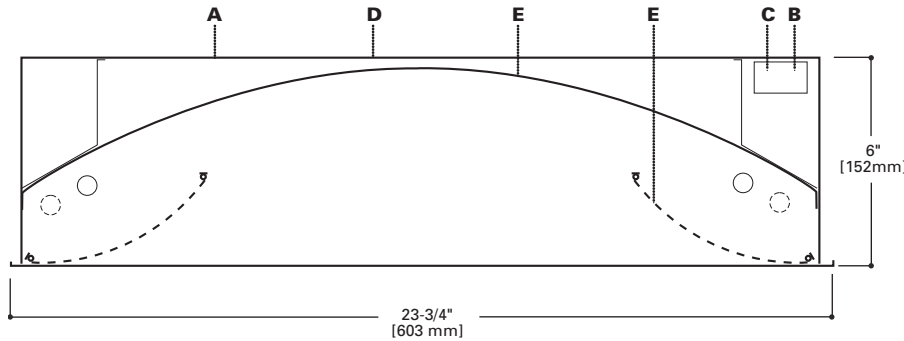
Indirect reflector has high reflectance baked matte white enamel finish for luminous uniformity. A pair of positively retained side-mounted direct lamp shields is constructed of heavy gauge perforated steel with high reflectance painted after fabrications finish and milky white over-layer diffuser for visual comfort. All reflectors are precision formed in a computer-controlled operation.

Catalog #		Type	B2
Project		Date	
Comments			
Prepared by			

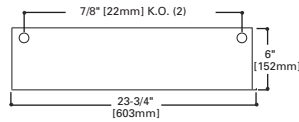
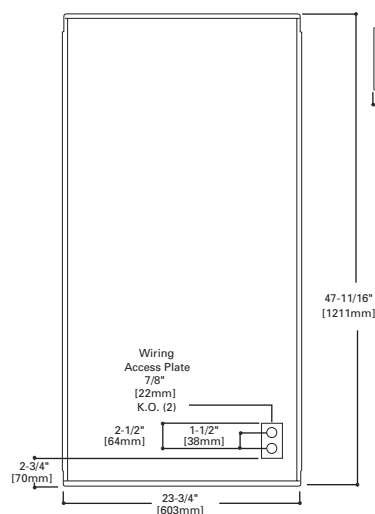


**2RDI-S-228T5**  
**2RDI-S-428T5**  
**2RDI-S-254T5HO**  
**2RDI-S-454T5HO**

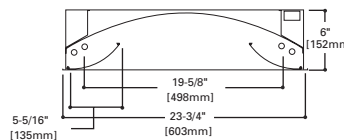
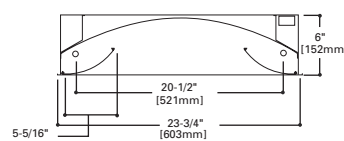
**T5 OR T5HO LAMPS**  
**2' X 4' Recessed**  
**Direct/Indirect**  
**Side-Mount**



## MOUNTING DATA



## LAMP CONFIGURATIONS



## CEILING COMPATIBILITY

G Grid/Lay-in Standard	T Slot Grid	F Drywall Frame Kit	Ceiling Type**	Trim Type
			Exposed Grid	G
			Concealed T	G or T
			Slot Grid	G or T
			Flange	***

*Ovation*  
**T5**

## ENERGY DATA

Input Watts:

### EB Ballast & STD Lamps

228T5 (68)  
 428T5 (136)  
 254T5 (120)  
 454T5 (240)

Luminaire Efficacy Rating

LER = FL58

Catalog Number: 2RDI-S-228T5RP

Yearly Cost of 1000 lumens,

3000 hrs at .08 KWH = \$4.14

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

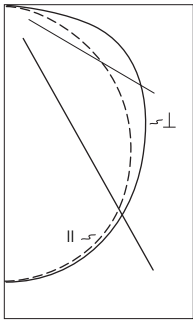
\*\*Consult Pre Sales Technical Support.

\*\*\*See Drywall Frame Kit Accessory

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**  
 Safe and convenient means of disconnecting power





**2RDI-S-228T5RP**  
Electronic Ballast  
F28T5/835 Lamps  
2900 Lumens

Spacing criterion:  
(II) 1.3 x mounting  
height, (⊥) 1.3 x  
mounting height  
Efficiency 67.3%

Test Report:  
2RDIS228T5RP.IES

LER = FL58

Yearly Cost of 1000  
lumens, 3000 hrs at  
.08 KWH = \$4.14

**Coefficients of Utilization**

rc	Effective floor cavity reflectance											
	80%				70%				20%			
	70	50	30	10	70	50	30	10	50	30	10	0%
rw	70	50	30	10	70	50	30	10	50	30	10	0
<b>RCR</b>												
0	80	80	80	80	78	78	78	78	75	75	75	72
1	73	70	67	65	71	68	66	64	66	63	61	63
2	67	61	56	53	65	60	55	52	57	54	51	55
3	61	54	48	44	59	53	48	43	51	46	43	49
4	56	48	42	37	54	47	41	37	45	40	36	43
5	51	42	36	31	49	41	35	31	40	35	31	38
6	47	37	31	27	45	37	31	27	36	30	26	34
7	43	34	28	23	42	33	27	23	32	27	23	31
8	39	30	24	20	38	30	24	20	29	24	20	28
9	36	27	21	17	35	27	21	17	26	21	17	25
10	34	25	19	15	33	24	19	15	23	19	15	23

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	991	17.1	25.4
0-40	1626	28.0	41.7
0-60	2917	50.3	74.7
0-90	3902	67.3	100.0
0-180	3602	67.3	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	67	75	57	67
30 x 30	61	66	49	55
30 x 30	59	61	44	46
60 x 60	61	64	54	59
60 x 60	58	58	48	48

**Candela**

Angle	Along II	45°	Across ⊥
0	1269	1269	1269
5	1263	1260	1266
10	1248	1248	1252
15	1222	1223	1228
20	1183	1186	1192
25	1132	1137	1148
30	1070	1079	1096
35	996	1014	1037
40	913	941	975
45	820	863	912
50	719	781	849
55	609	698	784
60	494	616	718
65	378	537	654
70	270	458	584
75	180	374	486
80	108	257	297
85	42	79	105
90	0	0	0

**ORDERING INFORMATION**

Sample Number: 2RDI-S-228T5RP-120V-EBT1-U

<b>Width</b> 2=2' Width	<b>Series</b> RDI=Ovation Series (Recessed Direct/Indirect)	<b>Trim Type</b> Blank=Grid/Lay-in (Standard)	<b>Lamp Position</b> S=Side Mount	<b>Number of Lamps</b> 1=1 Lamp 2=2 Lamps 3=3 Lamps 4=4 Lamps T1=2' x 4' fixture with one Biax Lamp at each end T2=2 Tandem Lamps (Biax) T3=3 Tandem Lamps (Biax)	<b>Lamp Shield</b> X=Solid Matte White RP=Round Perforated White Steel	<b>Voltage</b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal 120/277 Voltage	<b>Options</b> Lamps=Lamps Installed GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed EL=Emergency Installed	<b>Ballast Type</b> <sup>2</sup> Blank=Standard Magnetic Biax Ballast EB=Electronic Instant Start ER=T8 Electronic Program Rapid Start. Total Harmonic Distortion < 10% TEB=T5 Biax Elec Instant Start. Total Harmonic Distortion < 10% DLS=Digital Lighting System Dimming	<b>Options</b> PLUS=Higher Ballast Factor > 1.13. Total Harmonic Distortion < 20% RLS=Rotor Lock Socket (T8 Lamp only) RIF1=Radio Interference Suppressor REP=Riveted End Plates LSC=Lamp Shield Cable ST=Semi-Specular Tannenbaum	<b>Lamp Size</b> 5=T5 Biax 8=T8 T=T5 Linear	<b>Number of Ballasts</b> 1= 1 Ballast 2= 2 Ballast 3= 3 Ballast	<b>Packaging</b> U=Unit Pack PALC=Palletized Fixtures in Carton
----------------------------	--	--	--------------------------------------	--	--	--	--	--	--	--	---	---

Notes: 1 2' x 2' and 2' x 4' Center Lamp Shield model only.  
2 Products also available in non-US voltage and frequencies for international markets

**ACCESSORIES**

EQ = T-BAR Safety Earthquake Clips (Use Four Per Fixture)  
DF-24-W = Drywall Frame Kit

**SHIPPING INFORMATION**

Catalog No.	Wt.
2RDI-S-228T5RP	25 lbs.
2RDI-S-428T5RP	25 lbs.
2RDI-S-254T5RP	25 lbs.
2RDI-S-454T5RP	25 lbs.

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The Ovation Series is a complete family of recessed direct/indirect luminaires featuring pleasant modern architectural styling, computer-designed optics and the latest energy efficient lamp and ballast technology. The luminaire combines a matte white indirect reflector and two perforated direct lamp shields to provide optimum brightness control. All components are located above the ceiling plane for a clean architectural appearance in the finished space. Carefully balanced design elements combine to provide an efficient and exciting, high performance alternative to traditional general lighting. Ovation is an excellent choice for a wide variety of commercial applications.

## SPECIFICATION FEATURES

### A ... Construction

Nominal 6" deep housing is die formed of code gauge, prime cold rolled steel. Heavy gauge end plates are securely attached with screws for strength and rigidity and the elimination of gaps. Four auxiliary fixture end suspension points are provided. KOs for continuous row wiring. Large access plate for supply connection.

### B ... Electrical\*

Ballasts are Class "P" and are positively secured. Rotor-lock lampholders ensure positive lamp

retention. UL/CUL listed. Suitable for damp locations.

### C ... Ballast Access

Ballast can be removed from below the ceiling.

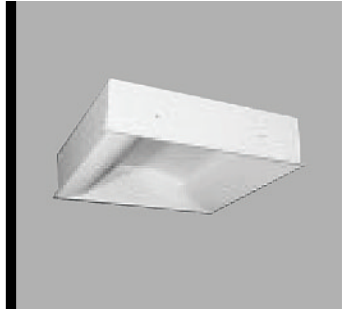
### D ... Finish

Durable cold rolled steel with multistage, iron phosphate pretreatment and white enamel finish to ensure maximum bonding and rust inhibition.

### E ... Reflectors

Indirect reflector has high reflectance baked matte white enamel finish for luminous uniformity. A pair of positively retained direct lamp shields constructed of heavy gauge perforated steel with high reflectance painted after fabrication finish and milky white overlay diffuser for visual comfort. All reflectors are precision formed in a computer-controlled operation.

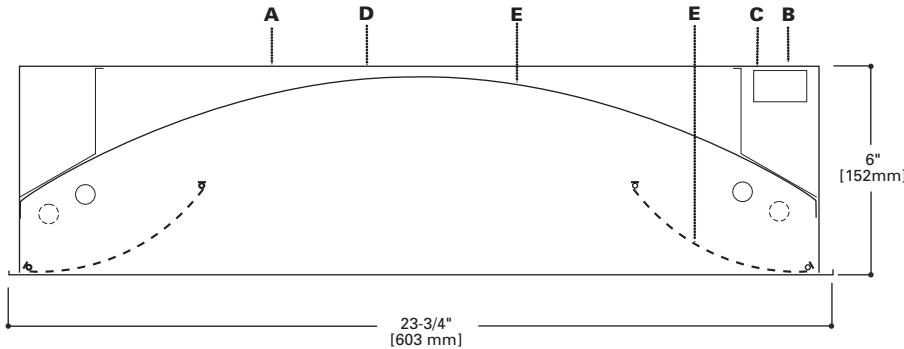
Catalog #		Type
Project		B3
Comments		Date
Prepared by		



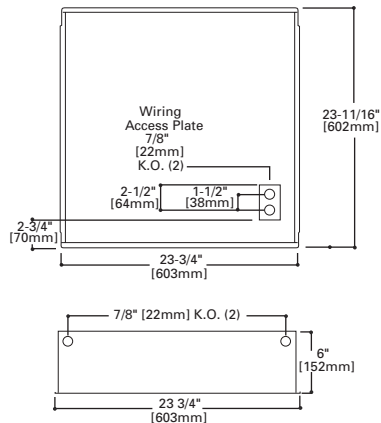
**2RDI-**  
**S-214T5**  
**S-414T5**  
**S-224T5HO**  
**S-424T5HO**

**T5 OR T5HO LAMPS**  
**2' X 2' Recessed**  
**Direct/Indirect**  
**Side-Mount**

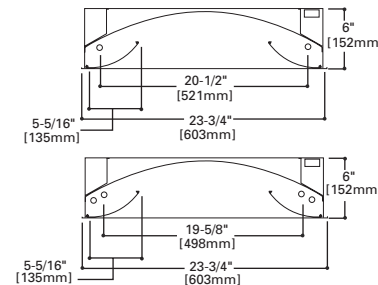
*Ovation*  
 15



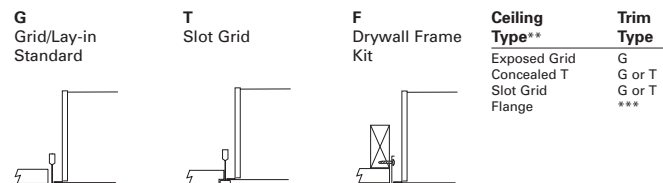
## MOUNTING DATA



## LAMP CONFIGURATIONS



## CEILING COMPATIBILITY



## ENERGY DATA

Input Watts:

### EB Ballast & STD Lamps

214T5 (38)

414T5 (76)

224T5 (52)

424T5 (104)

Luminaire Efficacy Rating

LER = FL49

Catalog Number: 2RDI-S-214T5RP

Yearly Cost of 1000 lumens,

3000 hrs at .08 KWH = \$4.90

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

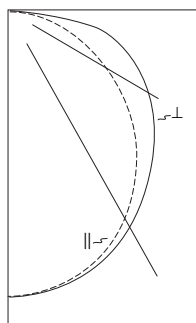
\*\*Consult Pre Sales Technical Support.

\*\*\*See Drywall Frame Kit Accessory

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**  
 Safe and convenient means of disconnecting power





**2RDI-S-214T5RP**  
Electronic Ballast

F14/T5/835 Lamps  
1350 Lumens

Spacing criterion:  
(||) 1.2 x mounting height,  
(⊥) 1.3 x mounting height

Efficiency 64.8%

Test Report  
2RDIS214T5RP.IES

LER = FL49

Yearly Cost of 1000 lumens, 3000 hrs at .08 KWH = \$4.90

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																	
	80%			70%			50%			30%			10%			0%		
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																		
0	77	77	77	77	75	75	75	75	72	72	72	69	69	69	66	66	66	65
1	71	68	65	63	69	66	64	62	63	61	60	61	59	58	59	57	56	55
2	64	59	55	51	63	58	54	50	56	52	49	53	51	48	51	49	47	46
3	59	52	47	43	57	51	46	42	49	45	42	47	44	41	46	43	40	39
4	54	46	41	36	52	45	40	36	44	39	35	42	38	35	41	37	35	33
5	49	41	35	31	48	40	34	30	39	34	30	37	33	30	36	32	29	28
6	45	36	31	26	44	37	30	26	35	30	26	34	29	26	33	29	25	24
7	42	33	27	23	40	32	27	23	31	26	23	30	26	22	29	25	22	21
8	38	29	24	20	37	29	23	20	28	23	20	27	23	19	26	22	19	18
9	35	26	21	17	34	26	21	17	25	20	17	24	20	17	24	20	17	15
10	33	24	19	15	32	24	18	15	23	18	15	22	18	15	22	18	15	14

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	455	16.9	26.0
0-40	746	27.6	42.6
0-60	1329	49.2	75.9
0-90	1750	64.8	100.0
0-180	1750	64.8	100.0

**Typical VCP Percentages**

Room Size (Ft.)	Height Along		Height Across	
	8.5'	10.0'	8.5'	10.0'
20 x 20	70	76	59	68
30 x 30	65	68	53	57
30 x 60	64	66	48	49
60 x 30	65	68	58	62
60 x 60	64	64	52	52

**Candela**

Angle	Along	45°	Across ⊥
0	582	582	582
5	581	580	583
10	573	575	577
15	559	562	566
20	539	544	549
25	514	522	530
30	484	494	506
35	449	464	478
40	409	429	449
45	366	390	420
50	319	351	390
55	268	312	359
60	218	272	328
65	169	233	298
70	125	192	263
75	86	146	216
80	46	89	130
85	16	29	46
90	0	0	0

**ORDERING INFORMATION**

Sample Number: 2RDI-S-214T5RP-120V-EBT1-U

<b>Width</b> 2=2' Width	<b>Number of Lamps</b> 2=2 Lamps 4=4 Lamps	<b>Lamp Shield</b> X=Solid Matte White RP=Round Perforated White Steel	<b>Ballast Type <sup>2</sup></b> EB=Electronic Instant Start DLS=Digital Lighting System Dimming	<b>Options</b> RIF1=Radio Interference Suppressor REP=Riveted End Plates LSC=Lamp Shield Cable ST=Semi-Specular Tannenbaum	<b>Packaging</b> U=Unit Pack PALC=Palletized Fixtures in Carton
<b>Series</b> RDI=Ovation Series (Recessed Direct/Indirect)	<b>Wattage</b> 14T5=14W T5 (24") <sup>1</sup> 24T5=24W T5HO (24") <sup>1</sup>	<b>Voltage <sup>2</sup></b> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal 120/277 Voltage	<b>Lamp Size</b> T=T5 Linear		
<b>Trim Type</b> Blank=Grid/Lay-in (Standard)		<b>Options</b> Lamps=Lamps Installed GL=Single Element Fuse GM=Double Element Fuse Flex=Flex Installed EL=Emergency Installed	<b>Number of Ballasts</b> 1=1 Ballast 2=2 Ballast 3=3 Ballast		
<b>Lamp Position</b> S=Side Mount					

Notes: 1 2' x 2' and 2' x 4' Center Lamp Shield model only.  
2 Products also available in non-US voltage and frequencies for international markets

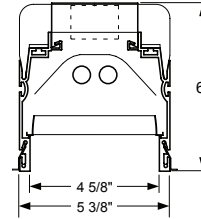
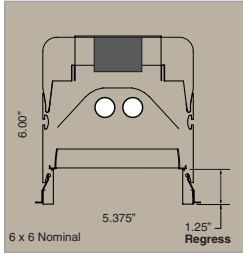
**ACCESSORIES**

EQ = T-BAR Safety Earthquake Clips (Use Four Per Fixture)  
DF-22-W = Drywall Frame Kit

**SHIPPING INFORMATION**

Catalog No.	Wt.
2RDI-S-214T5	15.5 lbs.
2RDI-S-414T5	15.5 lbs.
2RDI-S-224T5	15.5 lbs.
2RDI-S-424T5	15.5 lbs.





**GB66SL10RC**  
 5 3/8" wide recessed luminaire

2 x T5HO



**Construction**

**Housing:** Shall be constructed of 6063T5, 0.10" minimum thickness extruded aluminum reveal and CRS body. Available in one piece, unbroken lengths up to 12' with solid regress divider every 4'.

**Joiner System:** Automatic alignment, no loose parts, one tool to tighten two factory installed bolts for a hairline seam. No light leaks.

**Ballast:** Osram - Sylvania or equal electronic RS ballast with less than 10% THD is standard: **ERS**.

**Mounting and Feed:** Shall be recessed into a ceiling system (specify **REC**).

**Electrical**

UL listed wiring and components throughout. Housing is completely wired with quick-connect plugs at all mating joints and individually tested. All fixtures bear UL & CUL Dry Location labels. Damp Location labels are available. Specify **DL** in the Options field.

**Optical Performance**

**Reflectors:** Shall be formed semi specular aluminum.

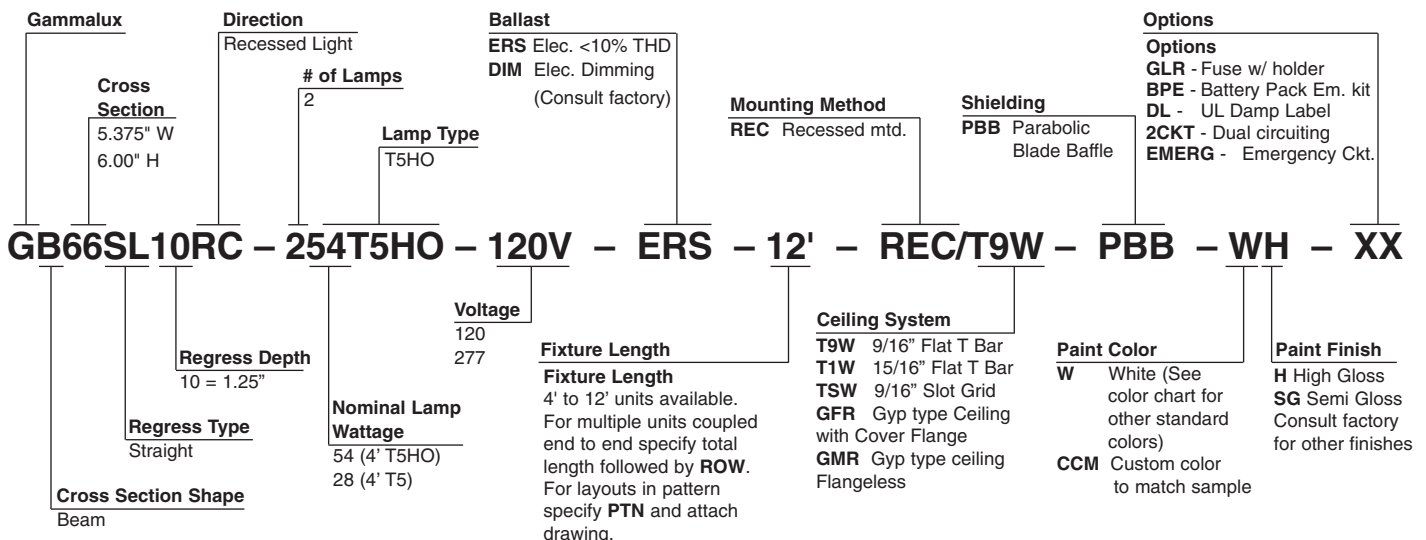
**Acrylic satin Lens:** Specify PBB for optional 7/8" high, specular parabolic blade baffle.

**Performance:** Independent photometric laboratory testing - ITL or equal - is required. Luminaire is 44% efficient.

**Finish**

Housing assembly is electrostatically sprayed with high solids aliphatic two component polyurethane to an average thickness of 2 mils. over acid etching primer. High gloss or semi gloss are standard. Consult with factory for other finishes. Specify **H** for high gloss in Paint Finish field. Specify **SG** for semi gloss.

**Standard Features**





**Photometric Report**

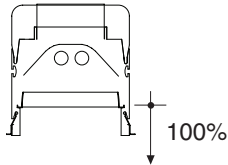
**GB66RCSL10-254T5HO-120VERS-4'-REC-PBB-WH**

Test: ITL # 61833 04/30/09

IES Data file: ITL61833.IES

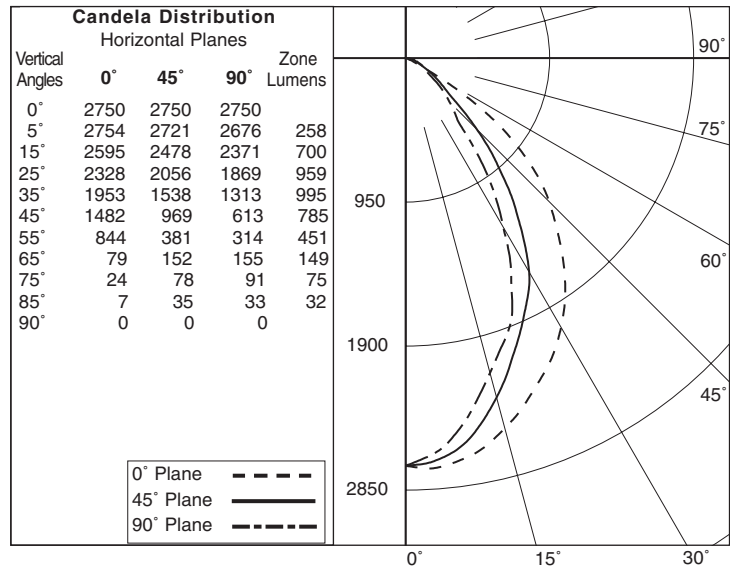
Lamp: 2-FP54T5HO (5000 lumens)

**44.0% Efficiency**



LUMINANCE DATA IN CANDELA/SQ M  
ANGLE AVERAGE AVERAGE AVERAGE

IN DEG	0-DEG	45-DEG	90-DEG
45	15249.	9970.	6307.
55	10706.	4833.	3983.
65	1360.	2617.	2668.
75	675.	2193.	2558.
85	584.	2922.	2755.



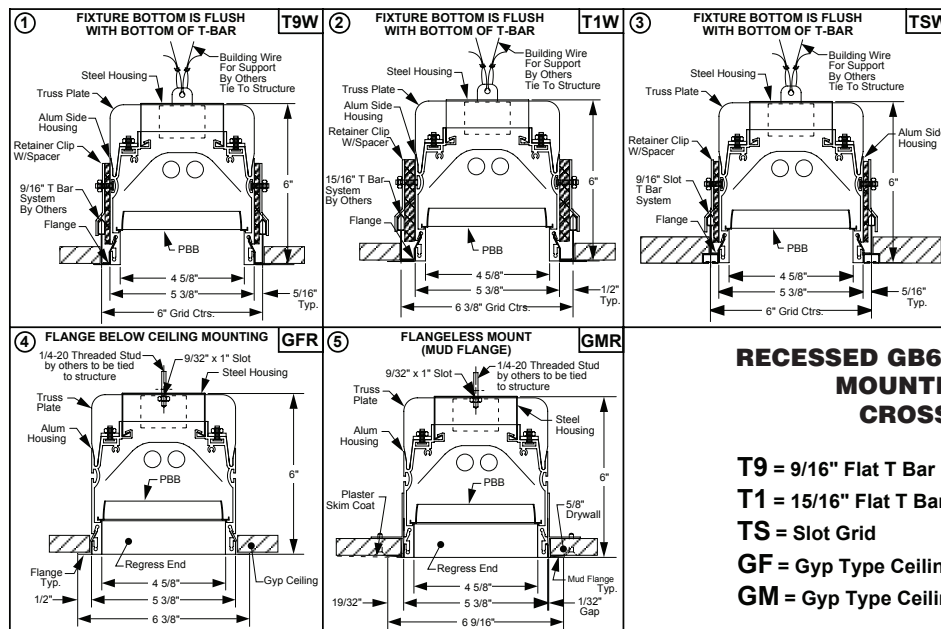
**Coefficients of Utilization – Zonal Cavity Method**

Effective Floor Cavity Reflectance (rfc) = 0.20

RCC	80%				70%				50%				30%			
	RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	
RCR																
0	.52	.52	.52	.52	.51	.51	.51	.51	.49	.49	.49	.47	.47	.47	.47	
1	.49	.48	.46	.45	.48	.47	.45	.44	.45	.44	.43	.43	.42	.41	.41	
2	.46	.43	.41	.39	.45	.42	.40	.38	.41	.39	.37	.39	.38	.36	.36	
3	.43	.39	.36	.34	.42	.38	.36	.33	.37	.35	.33	.36	.34	.32	.32	
4	.40	.35	.32	.30	.39	.35	.32	.30	.34	.31	.29	.33	.31	.29	.29	
5	.37	.32	.29	.26	.36	.32	.29	.26	.31	.28	.26	.30	.28	.26	.26	
6	.34	.30	.26	.24	.34	.29	.26	.24	.28	.26	.24	.28	.25	.23	.23	
7	.32	.27	.24	.22	.32	.27	.24	.21	.26	.23	.21	.26	.23	.21	.21	
8	.30	.25	.22	.20	.30	.25	.22	.20	.24	.21	.19	.24	.21	.19	.19	
9	.28	.23	.20	.18	.28	.23	.20	.18	.23	.20	.18	.22	.20	.18	.18	
10	.27	.22	.19	.17	.26	.21	.18	.16	.21	.18	.16	.21	.18	.16	.16	

**Mtg. Dimensiones**

Recessed luminaire mounting dimensions and overall luminaire dimensions are determined in part, by the ceiling system in which they are installed. Therefore we can not provide mounting dimensions in this document.



**RECESSED GB66SL10RC LUMINAIRE MOUNTING SYSTEMS CROSS SECTIONS**

- T9** = 9/16" Flat T Bar
- T1** = 15/16" Flat T Bar
- TS** = Slot Grid
- GF** = Gyp Type Ceiling with Cover Flange
- GM** = Gyp Type Ceiling Flangeless (Mud Flange)

**DESCRIPTION**

Low brightness 7-3/8" aperture reflector for use with (2)18W or 26W Quad Tube 4-pin compact fluorescent lamps. The precisely formed non-imaging optical reflector ensures a maximum 55° cutoff to lamp and lamp image and the one piece design eliminates light leaks at the ceiling. Standard features include low iridescent finish on all reflector colors to eliminate "rainbowing" and venting to ensure maximum lamp life and lumen output. Optics offer unparallelled performance in glare free lighting with a smooth beam. Open downlight, lens, and open wall wash trims are interchangeable within the same housing.

<b>Catalog #</b>		<b>Type</b>	D
<b>Project</b>			
<b>Comments</b>		<b>Date</b>	
<b>Prepared by</b>			

**SPECIFICATION FEATURES**

**A ... Reflector/Baffle**

.050 thick aluminum, in a one piece spun parabolic contour. Available in a variety of Alzak® finishes. Positive reflector mounting, without tools, pulls trim tight to ceiling. Also available with white or black baffle.

**B ... Trim Ring Options**

Self flanged or molded white trim ring. Rimless trim ring accessories available.

**C ... Socket Connector**

One piece die cast aluminum connection allows venting for maximum thermal performance.

**D ... Housing Mounting Frame**

One piece precision die cast aluminum 1-1/2" deep collar accommodates varying dimensions of ceiling materials.

**E ... Universal Mounting Bracket**

Accepts 1/2" EMT, C Channel, T bar fasteners, and bar hangers. Adjusts 5" vertically from above or below ceiling.

**F ... Conduit Fittings**

Die cast screw tight connectors.

**G ... Junction Box**

Listed for eight #12AWG (four in, four out) 90°C conductors feed through branch wiring.

1/2" and two 3/4" pry outs. Positioned to allow straight conduit runs. Access to junction box by removing reflector.

**H ... Socket**

26W lamps: 4-pin G24q3.  
18W lamps: 4-pin G24q2 base. Bases have fatigue free stainless steel lamp spring to ensure positive lamp retention.

**I ... Ballasts**

Electronic ballast provides full light output and rated lamp life. Provides flicker free and noise free operation and starting. End of lamp life protection is standard.

**Labels**

cULus listed, C.S.A. certified, standard damp label, IBEW union made.



**C7218, C7226  
7251/7250**

**(2) 18W, 26W Quad  
Compact Fluorescent**

**7-3/8" OPEN DOWNLIGHT**

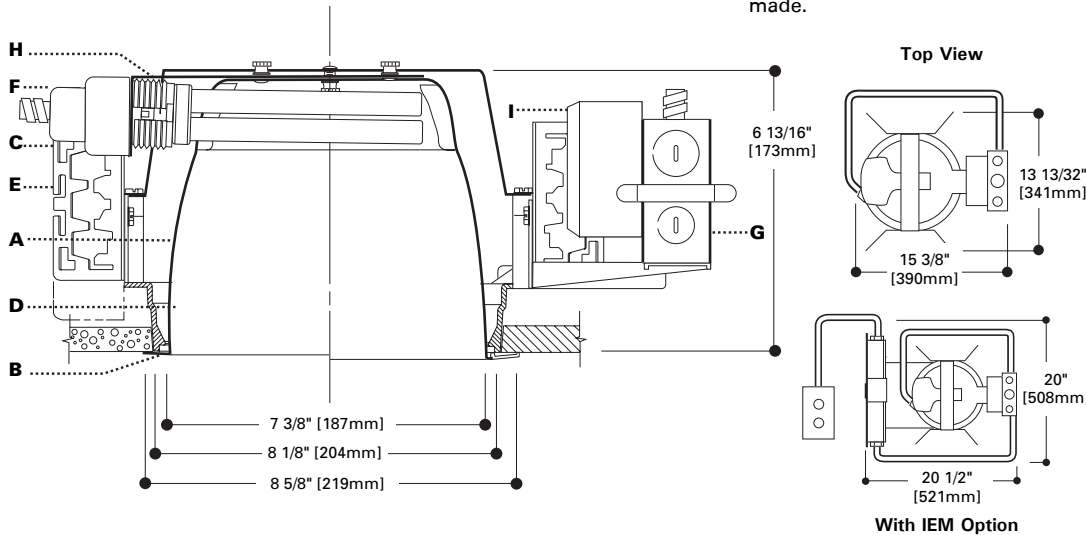
**Energy Data**

(2) 26W Quad 4-pin  
Ballast: Electronic  
120V input watts: 50 Line Amps: 0.45  
277V Input Watts: 50 Line Amps: 0.20  
Power Factor: >.99, THD: <10%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

(2) 18W Quad 4-pin  
Ballast: Electronic  
120V input watts: 37 Line Amps: 0.32  
277V Input Watts: 37 Line Amps: 0.14  
Power Factor: >.99, THD: <10%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

**NOTES:**

Accessories should be ordered separately. For additional options, please consult your Cooper Lighting Representative. Alzak is a registered trademark of Aluminum Company of America. Hi-Lume is a registered trademark of Lutron Co., Inc.



**ORDERING INFORMATION**

Sample Number: Complete unit consists of housing, ballast and trim.

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**Housing**

**C7**: 7" Horizontal Lamp

**Number of Lamps**

**2**: 2 Lamps

**Wattage**

**18**: 18W DTT Lamp

**26**: 26W DTT Lamp

**Ballast**

**E**: 120/277V 50/60 Hz Electronic

**3E**: 347V 50/60 Hz Electronic

**1D**: 120V Dimming Ballast

**2D**: 277V Dimming Ballast

**Options**

**CP**: Chicago Plenum

**EM**: Emergency Module with remote test switch

**IEM**: Emergency Module with integral test switch

**2C**: (2) ballasts for Hi-Low Switching

**2CMS**: 2 Circuit Master Satellite (2 housings, order 2 trims)

**Trims**

**7251**: Self Flanged

**7250**: Molded Trim Ring

**7251E**: Self Flanged use with IEM

**7250E**: Molded Trim Ring use with IEM

**Finish**

**LF**: Low Irdescent Clear

**H**: Haze

**WMH**: Warm Haze

**G**: Gold

**WH**: Wheat

**W**: Gloss White

**GP**: Graphite

**GPH**: Graphite Haze

**K**: Cognac

**KH**: Cognac Haze

**BB**: Black Baffle (7250 only)

**WB**: White Baffle (7250 only)

**Option**

**WF**: White Painted Flanged (Self Flanged only)

**Accessories**

**HB26**: C Channel Bar Hangers, 26" Long, Pair

**HB50**: C Channel Bar Hangers, 50" Long, Pair

**TRM7**: Metal Trim Ring, Specify Finish

**TRR7**: Rimless Trim Ring, White

**FK5**: 5 Amp Field Installable Fuse Kit 300V Max

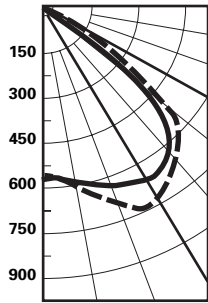
**DT7**: Deco Trims

**RMB-22**: Wood Joist Bar Hanger, 22" Long, Pair

**HSA7**: Slope Adapter for 7" Aperture Housings, Specify Slope

PHOTOMETRICS

Candlepower Distribution



Test No. H23193  
**C7218-7250LI**  
**Open Reflector**  
 Lamp=(2) 18W DTT  
 Lumens=1250 each  
 Spacing Criteria=  
 0°=1.5, 90°=1.6  
 Efficiency=59.3%

— 0°  
 - - 90°

Candlepower

Deg.	CD	0°	90°
0	585	585	
5	586	608	
15	618	709	
25	646	741	
35	625	657	
45	401	504	
55	164	171	
65	6	7	
75	0	0	
85	0	0	
90	0	0	

Average Luminance

Deg.	CD/SQ M	0°	90°
45	20544	25832	
55	10371	10794	
65	506	601	
75	0	0	
85	0	0	

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
5'6"	19	9'0"
6'6"	14	10'6"
8'0"	9	13'0"
10'0"	6	16'0"
12'0"	4	19'6"
14'0"	3	22'6"

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial, apply appropriate light loss factors where necessary.

**Reflector Multiplier:**  
 Haze=.96  
 Straw=.99  
 Wheat=.95

**EM Multiplier (in emergency mode)**  
 EM=.26

Zonal Lumen Summary

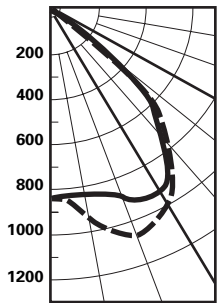
Zone	Lumens	%Lamp	%Luminaire
0-30	583	23.3	39.3
0-40	987	39.5	66.6
0-60	1474	59.0	99.4
0-90	1483	59.3	100.0
90-180	0	0.0	0.0
0-180	1483	59.3	100.0

Coefficient of Utilization

rc	80%				70%			50%		30%		10%		0%
rw	70	50	30	10	50	30	10	50	10	50	10	50	10	0
RCR														
0	71	71	71	71	69	69	69	66	66	63	63	61	61	59
1	67	65	63	62	64	62	61	61	59	59	57	57	56	54
2	63	60	57	55	59	56	54	57	53	55	52	54	51	50
3	59	55	52	49	54	51	49	53	48	51	47	50	46	45
4	56	51	47	44	50	46	44	49	43	47	43	46	42	41
5	52	46	42	39	46	42	39	45	39	44	38	43	38	37
6	48	42	38	35	42	38	35	41	35	40	35	39	34	33
7	45	38	34	31	38	34	31	37	31	36	31	36	30	29
8	42	35	31	28	34	30	28	34	27	33	27	32	27	26
9	39	32	27	24	31	27	24	31	24	30	24	29	24	23
10	36	29	24	22	28	24	22	28	21	27	21	27	21	20

rc=Ceiling reflectance, rw=Wall reflectance, RCR=Room cavity ratio  
 CU Data Based on 20% Effective Floor Cavity Reflectance.

Candlepower Distribution



Test No. H23185  
**C7226-7250LI**  
**Open Reflector**  
 Lamp=(2) 26W DTT  
 Lumens=1800 each  
 Spacing Criteria=  
 0°=1.6, 90°=1.6  
 Efficiency=60.6%

— 0°  
 - - 90°

Candlepower

Deg.	CD	0°	90°
0	831	831	
5	835	861	
15	867	1023	
25	916	1063	
35	920	946	
45	601	753	
55	251	258	
65	9	11	
75	3	4	
85	0	0	
90	0	0	

Average Luminance

Deg.	CD/SQ M	0°	90°
45	30828	38625	
55	15872	16315	
65	772	944	
75	420	561	
85	0	0	

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
5'6"	27	9'0"
6'6"	20	10'6"
8'0"	13	13'0"
10'0"	8	16'6"
12'0"	6	19'6"
14'0"	4	23'0"

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial, apply appropriate light loss factors where necessary.

**Reflector Multiplier:**  
 Haze=.96  
 Straw=.99  
 Wheat=.95

**EM Multiplier (in emergency mode)**  
 EM=.18

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	839	23.3	38.5
0-40	1431	39.7	65.6
0-60	2166	60.2	99.3
0-90	2181	60.6	100.0
90-180	0	0.0	0.0
0-180	2181	60.6	100.0

Coefficient of Utilization

rc	80%				70%			50%		30%		10%		0%
rw	70	50	30	10	50	30	10	50	10	50	10	50	10	0
RCR														
0	72	72	72	72	70	70	70	67	67	64	64	62	62	61
1	68	66	65	63	65	63	62	63	60	60	58	58	57	56
2	64	61	58	56	60	58	55	58	54	56	53	55	52	51
3	60	56	53	50	55	52	49	54	49	52	48	51	47	46
4	57	51	48	45	51	47	44	49	44	48	43	47	43	42
5	53	47	43	40	46	43	40	45	39	44	39	43	39	38
6	49	43	39	36	42	38	35	41	35	41	35	40	35	34
7	46	39	34	31	38	34	31	38	31	37	31	36	31	30
8	42	35	32	28	35	31	28	34	28	33	27	33	27	26
9	39	32	27	24	32	27	24	31	24	30	24	30	24	23
10	36	29	25	22	29	24	22	28	22	27	21	27	21	20

rc=Ceiling reflectance, rw=Wall reflectance, RCR=Room cavity ratio  
 CU Data Based on 20% Effective Floor Cavity Reflectance.

**DESCRIPTION**

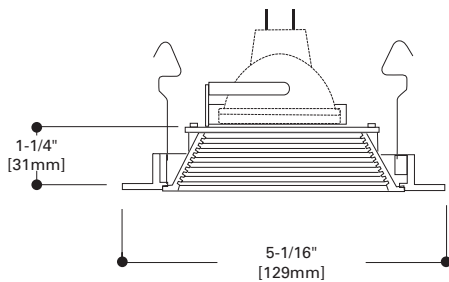
Baffle trim for 12V low voltage 4" H1499 family recessed housings. Die cast trim ring with Coilex® baffle. Reflector and trim ring available in a variety of finishes. Three "cat's paw" springs secure trim in housing.

**DESIGN FEATURES**

Cast aluminum trim ring available in Matte White, Silver, Polished Brass, Black Chrome, Satin Nickel, Antique Copper or Tuscan Bronze finishes. Baffle available in Black or White. Three pressure springs ensure positive retention in housing.

1493 is designed for use with the following small aperture housings;

- Low Voltage Housing
  - H1499T 50W 12V MR16
  - H1499RT 50W 12V MR16
  - H1499ICT 50W 12V MR16
  - H1499T75 75W 12V MR16



<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		D1 TRIM
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		



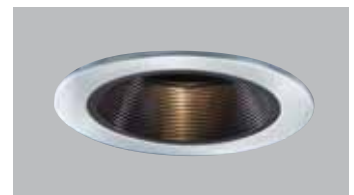
**1493P**  
Black Baffle with  
White Trim Ring



**1493W**  
White Baffle with  
White Trim Ring



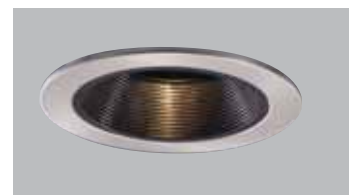
**1493PB**  
Black Baffle with  
Polished Brass Trim Ring



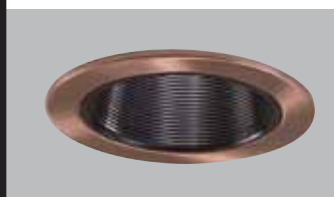
**1493SL**  
Black Baffle with Silver Trim Ring



**1493BC**  
Black Baffle with  
Black Chrome Trim Ring



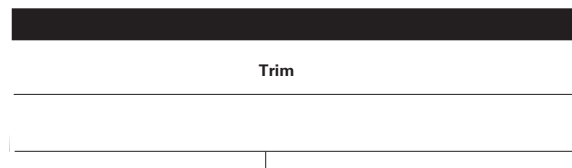
**1493SN**  
Black Baffle with  
Satin Nickel Trim Ring



**1493AC**  
Black Baffle with  
Antique Copper Trim Ring



**1493TBZ**  
Black Baffle with  
Tuscan Bronze Trim Ring



- 1493P**= Black Baffle, White Trim Ring
- 1493W**= White Baffle, White Trim Ring
- 1493PB**= Black baffle, Polished Brass Trim Ring
- 1493SL**= Black Baffle, Silver Trim Ring
- 1493BC**= Black Baffle, Black Chrome Trim Ring
- 1493SN**= Black Baffle, Satin Nickel Trim Ring
- 1493AC**= Black Baffle, Antique Copper Trim Ring
- 1493TBZ**= Black Baffle, Tuscan Bronze Trim Ring

1493  
Reflector Trim

4" TRIMS

Note: Specifications and Dimensions subject to change without notice.  
Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)

**DESCRIPTION**

The H1499TAT is a small aperture low voltage Non-IC AIR-TITE™ housing for providing accent and task lighting. The H1499TAT is designed for use in non-insulated ceilings. Non-IC Housing is AIR-TITE™ but insulation must be kept 3 inches away from all sides of housing.

Catalog #	Type
Project	<b>D1</b>
Comments	<b>Housing</b>
Prepared by	Date

**SPECIFICATION FEATURES**

**Housing**

Formed of CRS with powder coat finish.

**Plaster Frame**

- Galvanized steel die-formed construction.
- The housing can be removed from plaster frame to provide access to the junction box.
- Plaster frame features include:
  - Patented regressed locking screw positioned for securing hanger bars from below the ceiling.
  - Cutouts for easily crimping hanger bars in position.
  - AIR-TITE aperture gasket is pre-installed.
  - HALO identity embossed on plaster frame

**SLIDE-N-SIDE™ Junction Box**

- Positioned to accommodate straight conduit runs
- Four 1/2" trade size conduit knockouts with true pry-out slots
- Slide-N-Side wire traps allow non-metallic sheathed cable to be installed without tools and without removing knockouts.
- Accepts a wide range of non-metallic (type NM) sheathed cables - the standard cable types used in lighting in both U.S. and Canada.
  - Allows wiring connections to be made outside the junction box.

- Simply insert the cable directly into the trap after connections are made.
- Accommodates the following standard non-metallic sheathed cable sizes: (US) #14/2, #14/3, #12/2, #12/3 (Canada) #14/2, #14/3, #12/2

**"Quick Connect" Connectors**

Three quick connect wiring connectors included.

**GOT NAIL! Pass-N-Thru™ Bar Hangers**

- Pre-installed nail easily installs in regular lumber, engineered lumber and laminated beams.
- Safety and guidance system prevents snagging, ensures smooth straight nail penetration and allows bar hangers to be easily removed if necessary.
- Automatic levelling flange aligns the housing and lets you hold the housing in place with one hand while driving nails.
- Housing can be positioned at any point within 24" joist span.
- Pass-N-Thru™ feature allows bar hangers to be shortened without removing from plaster frame.
- Score lines allow "toolless" shortening for 12" joists.
- Bar hangers may be repositioned 90°.
- Integral T-bar clip snaps onto T-bars - no additional clips required.

**Socket**

GU5.3 socket with reflector plate for bi-pin 12V MR-16 lamps.

**Transformer**

Integral 120V magnetic transformer steps line voltage down to lamp operating voltage. For lamps up to 50W.

**Thermal Protector**

Thermal protector deactivates fixture if overheating occurs due to improper lamping or misapplied insulation.

**Labels**

- UL/cUL Listed 1598 Luminaire
- UL/cUL Listed for Damp Location
- UL/cUL Listed for Wet Location, covered ceiling - with select trims
- UL/cUL listed for Feed Through
- Certified Under ASTM-E283 for air tight construction
- IP rated (Improper Lamp)



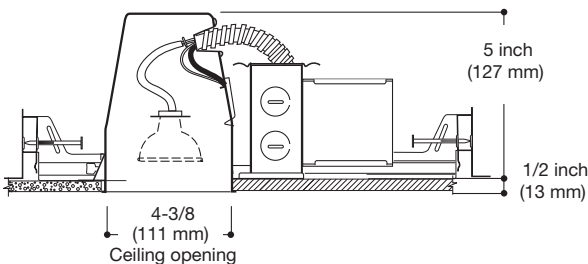
**H1499TAT**

**4" Non-Insulated Ceiling AIR-TITE™ Low Voltage Recessed Housing**

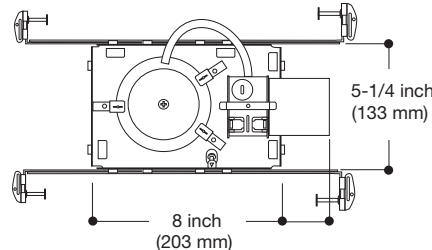
**4" TRIMS**

**FOR USE IN NONINSULATED CEILINGS OR INSULATED CEILINGS WHERE INSULATION CAN BE KEPT 3" FROM ALL SIDES OF FIXTURE**

**Transformer Data:**  
 Primary: 120VAC, 60Hz  
 Secondary: 11.5V±0.3V, 50VA  
 Insulation system: Class H  
 Nominal Amps with 50 watt, 12V rated Lamp: 0.50A  
 Nominal Watts with 50 watt, 12V rated Lamp: 57W



**Top View**





## ORDERING INFORMATION

SAMPLE NUMBER: H1499TAT-1421W

Order housing and trims separately.

## Housing

## Trims

H1499TAT= 4" Non-Insulated Ceiling  
Low Voltage Small  
Aperture AIR-TITE Housing

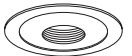
## REFLECTORS



1421

**Reflector Cone - 35° Tilt**  
50W 12V MR16  
**1421W**=White Reflector with White Trim Ring  
**1421C**=Specular Clear Reflector with White Trim Ring  
**1421AC**=Antique Copper Reflector, Antique Copper Trim Ring  
**1421H**=Haze Reflector with White Trim Ring  
**1421CG**=Champagne Gold Reflector with White Trim Ring  
**1421RG**=Residential Gold Reflector with White Trim Ring  
**1421MB**=Specular Black Reflector with White Trim Ring  
**1421SN**=Satin Nickel Reflector with Satin Nickel Trim Ring  
**1421TBZ**=Tuscan Bronze Reflector with Tuscan Bronze Trim Ring  
OD: 5-1/16" (129mm)

## BAFFLES



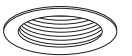
1419

**1 7/8" Open with Baffle - 35° Tilt**  
50W 12V MR16  
**1419P**=Black Baffle, White Trim Ring  
**1419AC**=Black Baffle, Antique Copper Trim Ring  
**1419W**=White Baffle, White Trim Ring  
**1419SN**=Black Baffle, Satin Nickel Trim Ring  
**1421TBZ**=Black Baffle, Tuscan Bronze Trim Ring  
OD: 5-1/16" (129mm)



1493

**Coilex® Baffle - 35° Tilt**  
50W 12V MR16  
**1493P**=Black Baffle, White Trim Ring  
**1493AC**=Black Baffle, Antique Copper Trim Ring  
**1493BC**=Black Baffle, Black Chrome Trim Ring  
**1493PB**=Black Baffle, Polished Brass Trim Ring  
**1493W**=White Baffle, White Trim Ring  
**1493SN**=Black Baffle, Satin Nickel Trim Ring  
**1493TBZ**=Black Baffle, Tuscan Bronze Trim Ring  
OD: 5-1/16" (129mm)



1453

**Metal Baffle - 35° Tilt**  
50W 12V MR16  
**1453AC**=Antique Copper Baffle, Antique Copper Trim Ring  
**1453SN**=Satin Nickel Baffle, Satin Nickel Trim Ring  
**1453TBZ**=Tuscan Bronze Baffle, Tuscan Bronze Trim Ring  
OD: 5-1/16" (129mm)

## ADJUSTABLES



1420

**Slot Aperture - 35° Tilt**  
(Slot - 1 3/8" X 2 1/8")  
50W 12V MR16  
**1420P**=White  
**1420AC**=Antique Copper  
**1420SN**=Satin Nickel  
**1420TBZ**=Tuscan Bronze  
OD: 5-1/16" (129mm)



1498

**Eyeball - 30° Tilt**  
50W 12V MR16  
**1498P**=White Eyeball, Black Baffle  
**1498AC**=Antique Copper Eyeball, Black Baffle  
**1498PB**=Polished Brass Eyeball, Black Baffle  
**1498W**=White Eyeball, White Baffle  
**1498BC**=Black Chrome Eyeball, Black Baffle  
**1498SN**=Satin Nickel Eyeball, Black Baffle  
**1498TBZ**=Tuscan Bronze Eyeball, Black Baffle  
OD: 5-1/16" (129mm)



1495

**Gimbal Adjustable - 30° Tilt**  
50W 12V MR16  
**1495P**=Satin White  
**1495AC**=Antique Copper  
**1495SN**=Satin Nickel  
**1495TBZ**=Tuscan Bronze  
OD: 5-1/16" (129mm)



1496

**Retractable Elbow Super Adjustable - 60° Tilt**  
50W 12V MR16  
**1496P**=White Eyeball and Trim Ring  
**1496AC**=Antique Copper Eyeball and Trim Ring  
**1496SN**=Satin Nickel Eyeball and Trim Ring  
**1496TBZ**=Tuscan Bronze Eyeball and Trim Ring  
OD: 5-1/16" (129mm)



1497

**Adjustable Mirror Trim - 90° Tilt**  
50W 12V MR16  
**1497P**=White  
OD: 5-1/16" (129mm)



1945

**Metropolitan Ice Light**  
50W 12V MR16  
**1945**=Clear Frosted  
**1945BLUE**=Blue Frosted  
OD: 5-5/16" (135mm)



1946

**Metropolitan Deco**  
50W 12V MR16  
**1946PB**=Polished Brass Accent with Green Tint Translucent Rings  
**1946BC**=Black Chrome Accent with Green Tint Translucent Rings  
OD: 5-5/8" (143mm)

## SHOWER LIGHT



1951

**Regressed Lens Shower Light**  
50W 12V MR16  
**1951P**=Shower Light, White Trim Ring, Specular Reflector  
**1951ACS**=Shower Light, Antique Copper Trim Ring, Specular Reflector  
**1951SNS**=Shower Light, Satin Nickel Trim Ring, Specular Reflector  
**1951TBZS**=Shower Light, Tuscan Bronze Trim Ring, Specular Reflector  
OD: 5-1/16" (129mm)



## Accessories

## Mounting Accessories

## Filters and Lenses

The following filters and lenses can be substituted for the cover glass supplied for use with MR16 lamps.

## Color Filters

**L112**=Red Gel Filter  
**L114**=Ultraviolet Dichroic Filter  
**L120**=Red Dichroic Filter  
**L121**=Amber Dichroic Filter  
**L122**=Yellow Dichroic Filter  
**L123**=Green Dichroic Filter  
**L124**=Daylight Blue Dichroic Filter  
**L125**=Blue Dichroic Filter  
**L127**=Cosmetic (2700°K) Dichroic Filter  
**L121**=Yellow Gel Filter  
**L121**=Amber Gel Filter

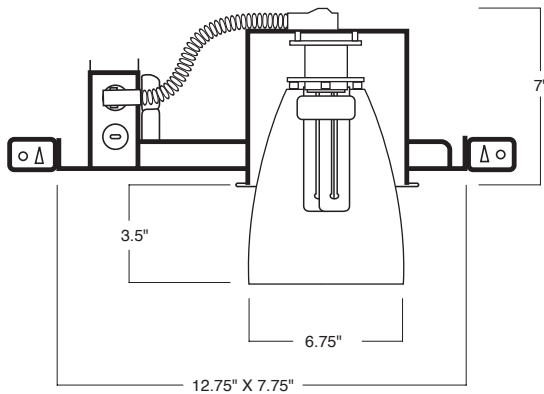
## Optical Lenses

**L100N**=Diffuse Sand Blasted Lens. Provides an even beam spread from MR16 lamps-especially useful in wall washing.  
**L111**=Soft Focus Lens. Smooths irregular beam pattern while maintaining high controlled illumination levels and beam angles.  
**L113**=Prismatic Spread Lens. Provides a symmetrical broadening of MR16 lamp beams.  
**L115**=Fans the MR16 beam to produce a wide rectangular illumination pattern.

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)

## 6" SEMI RECESSED DOWNLIGHT


**DELRAY  
LIGHTING  
INCORPORATED**
**4740**

## SPECIFICATION INFORMATION

**HOUSING ASSEMBLY**

- Pre-coated galvanized steel mounting frame and J-box.
- Telescopic bar hangers supplied, provides for off-center mounting on joists or T-bar.
- Self flange type trim for clean, contemporary appearance.
- Ground wire included (prewired).

**TWIST LOCK SOCKET**

- Push lamp in and twist clockwise to lock into place.
- Lamp will not fall out.
- Relamp with pole (with Changer accessory).

**DIFFUSER**

- Hand blown glass, available in four colors (please specify):
  - **I**—indigo
  - **M**—marine
  - **O**—opal
  - **T**—tangerine
- **WA**—white acrylic

**BALLAST**

- Standard in universal voltage 120V through 277V.
- Thermally protected rapid start electronic ballasts use 4-pin lamps
- .99 power factor with THD<10%.
- End of lamp life protection.

**ELECTRICAL**

- Allows 4-in/4-out #12 AWG conductors rated at minimum 90° C.
- J-box and ballast are both accessible through fixture.
- U.L. listed for use in damp locations.

**ACCESSORIES**

- **CHANGER** for re-lamp cup
- **CP**—Chicago plenum
- **FS**—inline fuse

**DIMMING**

- Voltage *must* be specified.
- Controls lumen output down to ±5%.
- Compatible dimmers required for all ballasts.
- **D3** Advance Mark X for 26, 32 or 42W lamp.
- **D4** Lutron Tu-Wire for 26 or 32W lamp. 120V *only*.
- **D5** Advance Mark VII for 26, 32 or 42W lamp.
- **D8** Lutron Hi-Lume for 26 or 32W lamp. Controls lumen output down to ±1%.
- **D9** Lutron Eco System for 26 and 32W lamps.

**EMERGENCY**

- Voltage *must* be specified.
- **EM** emergency power provides 650 lumens for one lamp for 90 minutes
- **EM13** emergency power provides 1300 lumens for one lamp for 90 minutes

## ORDERING INFORMATION

**LAMP**

- 1-26** 26W triple tube
- 1-32** 32W triple tube
- 1-42** 42W triple tube

**120V ELECTRONIC**

- 4740.I.1** 120V indigo
- 4740.M.1** 120V marine
- 4740.O.1** 120V opal
- 4740.T.1** 120V tangerine

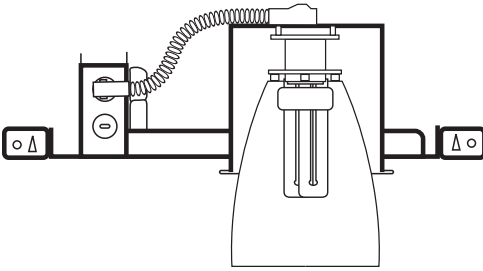
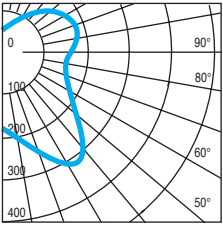
**277V ELECTRONIC**

- 4740.I.2** 277V indigo
- 4740.M.2** 277V marine
- 4740.O.2** 277V opal
- 4740.T.2** 277V tangerine

## SUBMITTAL INFORMATION

**TYPE:****PROJECT:****NOTES:****DESCRIPTION:**

BURBANK,  
CALIFORNIA,  
91505  
WWW.  
DELRAY  
LIGHTING.  
COM

**1-32W PLT****CP DISTRIBUTION****COEFFICIENTS OF UTILIZATION****% CEILING 80 (20% FLOOR)**

<b>% WALL</b>	<b>70</b>	<b>50</b>	<b>30</b>
0	96	96	96
1	85	80	76
2	77	69	63
3	70	61	54
4	64	54	46
5	59	48	40
6	54	43	35
7	50	38	31
8	46	34	27
9	43	31	24
10	39	28	21

**NOTES****4740.0**

1-32W triple tube  
 G24q-3 electronic socket  
 Total lumens: 2400  
 Spacing criteria: 1.7  
 Efficiency: 60.6%



**DESCRIPTION**

Low brightness 7-3/8" aperture lens downlight for use with (2)18W or 26W Quad Tube 4-pin compact fluorescent lamps. The deeply regressed lens provides superb shielding in comparison to shallow lenses. Reflector trim eliminates brightness at higher angles. Choice of lens types for various aesthetics. Open downlight, lens, and open wall wash trims are interchangeable within the same housing.

<b>Catalog #</b>		<b>Type</b>	DL
<b>Project</b>		<b>Date</b>	
<b>Comments</b>			
<b>Prepared by</b>			

**SPECIFICATION FEATURES**

**A ... Reflector**

Clear upper Alzak® reflector for maximum output. Positive reflector mounting, without tools, pulls trim tight to ceiling. Lower spun parabolic reflector, .050 thick aluminum, available in a variety of Alzak® finishes. Also available with white or black baffle.

**B ... Lens**

Choice of molded prismatic acrylic, opal diffuser, clear UV stabilized polycarbonate, prismatic glass, diffuse glass, clear glass or fresnel glass lens. Lens is fixed to lower reflector.

**C ... Trim Ring Options**

Self flanged or molded white trim ring.

**D ... Socket Connector**

One piece die cast aluminum connection allows venting

for maximum thermal performance.

**E ... Housing Mounting Frame**

One piece precision die cast aluminum 1-1/2" deep collar accommodates varying dimensions of ceiling materials.

**F ... Universal Mounting Bracket**

Accepts 1/2" EMT, C Channel, T bar fasteners, and bar hangers. Adjusts 5" vertically from above or below ceiling.

**G ... Conduit Fittings**

Die cast screw tight connectors.

**H ... Junction Box**

Listed for eight #12AWG (four in, four out) 90°C conductors feed

through branch wiring. For 1/2" and two 3/4" pry outs. Positioned to allow straight conduit runs. Access to junction box by removing reflector.

**I ... Socket**

26W lamps: 4-pin G24q3 base. 18W lamps: 4-pin G24q2 base. Bases have fatigue free stainless steel lamp spring to ensure positive lamp retention.

**J ... Ballasts**

Electronic ballast provides full light output and rated lamp life. Provides flicker free and noise free operation and starting.

**Labels**

cULus listed, C.S.A. certified, Wet label, IBEW union made.



**C7218, C7226  
7281/7280**

**(2) 18W, 26W Quad  
Compact Fluorescent**

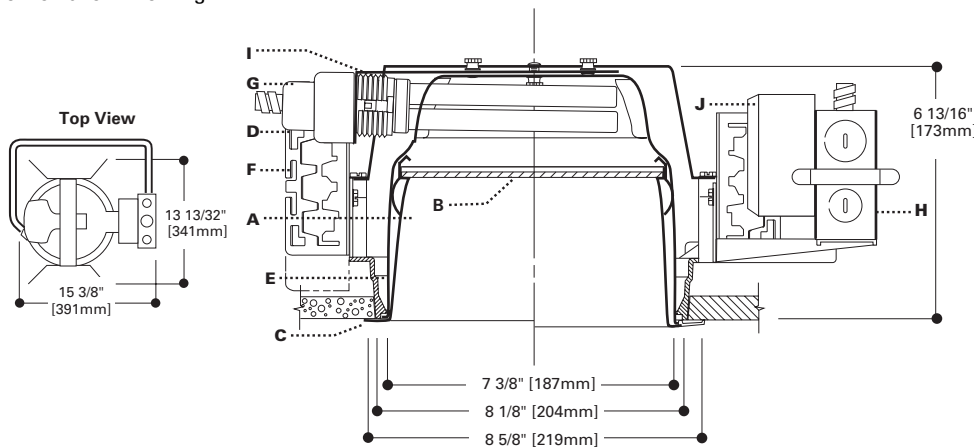
**7-3/8" LENSED DOWNLIGHT**

**Energy Data**

(2) 26W Quad 4-pin  
Ballast: Electronic  
120V input watts: 50, Line Amps: 0.45  
277V Input Watts: 50, Line Amps: 0.20  
Power Factor: >.99, THD: <10%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

(2) 18W Quad 4-pin  
Ballast: Electronic  
120V input watts: 37, Line Amps: 0.32  
277V Input Watts: 37, Line Amps: 0.14  
Power Factor: >.99, THD: <10%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

**NOTES:**  
Accessories should be ordered separately. For additional options, please consult your Cooper Lighting Representative. Alzak is a registered trademark of Aluminum Company of America.



**ORDERING INFORMATION**

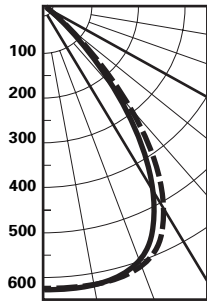
Sample Number: Complete unit consists of housing, ballast and trim.

<b>Housing</b> C7= 7" Horizontal Lamp	<b>Ballast</b> E= 120/277V 50/60 Hz Electronic 3E= 347V 50/60 Hz Electronic 1D= 120V Dimming Ballast 2D= 277V Dimming Ballast	<b>Options</b> CP= Chicago Plenum EM= Emergency Module with remote test switch 2C= (2) ballasts for Hi-Low Switching 2CMS= 2 Circuit Master Satellite (2 housings, order 2 trims)	<b>Trims</b> 7281= Self Flanged 7280= Lens, Molded Trim Ring	<b>Finish</b> LI= Low Iridescent Clear H= Haze WMH= Warm Haze G= Gold WH= Wheat W= Gloss White GP= Graphite GPH= Graphite Haze K= Cognac KH= Cognac Haze BB= Black Baffle (7280 only) WB= White Baffle (7280 only)	<b>Lens</b> 1= Prismatic Lens 2= Diffuse Lens 3= Clear Lens 1G= Prismatic Glass 2G= Diffuse Glass 3G= Clear Glass 4G= Fresnel Glass	<b>Option</b> WF= White Painted Flanged (Self Flanged only)	<b>Accessories</b> HB26= C Channel Bar Hangers, 26" Long, Pair HB50= C Channel Bar Hangers, 50" Long, Pair FK5= 5 Amp Field Installable Fuse Kit 300V Max RMB-22= Wood Joist Bar Hanger, 22" Long, Pair HSA7= Slope Adapter for 7" Aperture Housings, Specify Slope
--	---	---	--	--	--	--	--

PHOTOMETRICS



**Candlepower Distribution**



Test No. H23198  
**C7218-7281LI 1**  
**Reflector with Prismatic Lens**  
 Lamp=(2)18W DTT  
 Lumens=1250 each  
 Spacing Criteria=  
 0°=1.2, 90°=1.2  
 Efficiency=41.8%

**Candlepower**

Deg.	CD 0°	90°
0	633	633
5	637	631
15	641	635
25	574	595
35	397	448
45	186	221
55	81	86
65	11	11
75	0	0
85	0	0
90	0	0

**Average Luminance**

Deg.	CD/SQ M 0°	90°
45	9520	11346
55	5110	5413
65	961	935
75	0	0
85	0	0

**Cone of Light**

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
5'6"	21	7'0"
6'6"	15	8'0"
8'0"	10	10'0"
10'0"	6	12'6"
12'0"	4	15'0"
14'0"	3	17'6"

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial, apply appropriate light loss factors where necessary.

**Reflector Multiplier:**  
 Haze=.98  
 Straw=.99  
 Wheat=.95

**EM Multiplier (in emergency mode)**  
 EM=.26

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Luminaire
0-30	509	20.3	48.6
0-40	772	30.9	73.8
0-60	1010	40.4	96.6
0-90	1046	41.8	100.0
90-180	0	0.0	0.0
0-180	1046	41.8	100.0

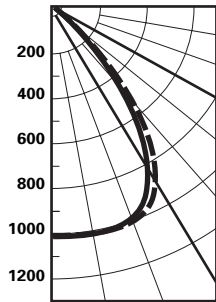
**Coefficient of Utilization**

rc	80%				70%				50%		30%		10%		0%
	rw	70	50	30	10	50	30	10	50	10	50	10	50	10	0
<b>RCR</b>															
0	50	50	50	50	49	49	49	46	46	45	45	43	43	42	
1	47	46	45	44	45	44	43	43	42	42	41	40	39	39	
2	45	43	41	39	42	40	39	41	38	39	37	38	36	36	
3	42	39	37	35	39	37	35	38	34	37	34	36	33	33	
4	40	36	34	32	36	34	32	35	31	34	31	33	31	30	
5	37	34	31	29	33	31	29	32	29	32	28	31	28	27	
6	35	31	28	26	31	28	26	30	26	30	26	29	26	25	
7	33	29	26	24	28	26	24	28	24	27	24	27	23	23	
8	31	27	24	22	26	24	22	26	22	25	22	25	21	21	
9	29	24	22	20	24	22	20	24	20	23	20	23	20	19	
10	27	23	20	18	22	20	18	22	18	22	18	21	18	17	

rc=Ceiling reflectance, rw=Wall reflectance, RCR=Room cavity ratio

CU Data Based on 20% Effective Floor Cavity Reflectance.

**Candlepower Distribution**



Test No. H23203  
**C7226-7281LI 1**  
**Reflector with Prismatic Lens**  
 Lamp=(2)26W DTT  
 Lumens=1800 each  
 Spacing Criteria=  
 0°=1.2, 90°=1.3  
 Efficiency=47.0%

**Candlepower**

Deg.	CD 0°	90°
0	1002	1002
5	995	1018
15	1015	1026
25	924	962
35	643	735
45	301	365
55	130	142
65	19	26
75	3	3
85	0	0
90	0	0

**Average Luminance**

Deg.	CD/SQ M 0°	90°
45	15440	18723
55	8221	8980
65	1631	2231
75	420	420
85	0	0

**Cone of Light**

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
5'6"	33	7'0"
6'6"	24	8'0"
8'0"	16	10'0"
10'0"	10	12'6"
12'0"	7	15'0"
14'0"	5	17'6"

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial, apply appropriate light loss factors where necessary.

**Reflector Multiplier:**  
 Haze=.96  
 Straw=.99  
 Wheat=.95

**EM Multiplier (in emergency mode)**  
 EM=.18

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Luminaire
0-30	811	22.5	48.0
0-40	1239	34.4	73.3
0-60	1631	45.3	96.4
0-90	1691	47.0	100.0
90-180	0	0.0	0.0
0-180	1691	47.0	100.0

**Coefficient of Utilization**

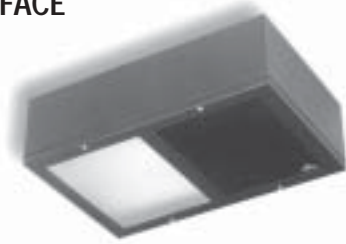
rc	80%				70%				50%		30%		10%		0%
	rw	70	50	30	10	50	30	10	50	10	50	10	50	10	0
<b>RCR</b>															
0	56	56	56	56	55	55	55	52	52	50	50	48	48	47	
1	53	52	50	49	51	50	48	49	47	45	44	45	44	43	
2	50	48	46	44	47	45	44	45	43	44	42	43	41	40	
3	47	44	42	40	43	41	39	42	39	41	348	40	37	37	
4	45	41	38	36	40	38	36	39	35	38	35	37	34	34	
5	42	38	35	32	37	34	32	36	32	36	32	35	31	31	
6	39	35	32	30	34	32	29	34	29	33	29	32	29	28	
7	37	32	29	27	32	29	27	31	26	31	26	30	26	25	
8	35	30	26	24	29	26	24	29	24	28	24	28	24	23	
9	32	27	24	22	27	24	22	27	22	26	22	26	22	21	
10	30	25	22	20	25	22	20	25	2-	24	20	24	20	19	

rc=Ceiling reflectance, rw=Wall reflectance, RCR=Room cavity ratio

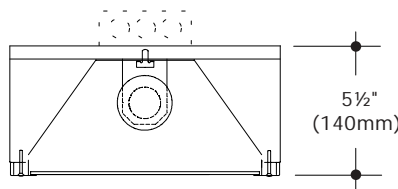
CU Data Based on 20% Effective Floor Cavity Reflectance.

## Darkroom Safelites

## SURFACE



Shown with Distributing Lens -DL  
in one compartment



## Description

Darkroom Safelites are task lighting fixtures required wherever photographic or X-ray film processing is performed. Filters must be selected to meet the requirements of the particular type of film that will be exposed to the light. Multiple-compartment fixtures allow safe processing of different types of film. Stainless steel construction for exposed surfaces is available for rooms with a corrosive atmosphere.

## Construction

- Housing and trim are 20 gauge steel
- Standard finish on surface models and trim of recessed models is black enamel
- Recessed housing has white polyester coating
- Trim is fully gasketed to insure light-tight compartments
- Plaster frame with attached junction box is provided for recessed models
- One 8" x 10" Eastman Kodak filter is provided for each compartment
- UL/cUL listed

## Electrical

- Wired for one medium base 120V incandescent lamp in each compartment
- Each compartment is to be individually switched
- Lamps over 15W are not recommended in filter compartments
- 75W maximum in distributing lens compartment in surface models
- Maximum lamp wattage in recessed models varies with ceiling condition

## To Specify

- Select catalog number.
- Add filter number and/or -DL for each compartment of model selected. Refer to filter data on back of this page.
- For recessed models, add appropriate suffix (-T or -IC) for ceiling condition.
- Add suffixes for options required to meet job conditions.



C. W. Cole & Company, Inc.  
2560 N. Rosemead Boulevard  
South El Monte, CA 91733-1593

Fax (626) 443-9253  
Tel. (626) 443-2473  
info@colelighting.com  
www.colelighting.com

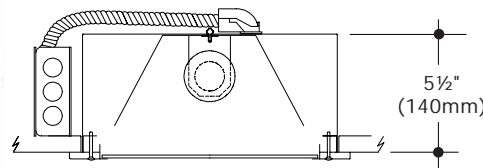
Catalog Numbers	Configuration	Dimensions
PH810-S-*		11 3/4" x 9 3/4" (299mm x 248mm)
PH810-2S-**-*		11 3/4" x 18 1/4" (299mm x 464mm)
PH810-3S-***-*		11 3/4" x 27 3/8" (299mm x 695mm)
PH810-4S-****-*		11 3/4" x 35 5/8" (299mm x 905mm)
PH810-4S-****-*		18 1/4" x 22 1/2" (464mm x 572mm)

\* Specify -DL and/or required filter      Feed location shown

## RECESSED



Shown with Distributing Lens -DL  
in one compartment



Catalog Numbers	Configuration	Dimensions	
		Housing	Trim
PH810-PB-*-†		11 3/4" x 9 3/4" (299 x 248)	13" x 10 7/8" (330 x 276)
PH810-2PB-**-†		11 3/4" x 18 1/4" (299 x 464)	13" x 19 1/2" (330 x 495)
PH810-3PB-***-†		11 3/4" x 27 3/8" (299 x 695)	13" x 28 5/8" (330 x 727)
PH810-4PB-****-†		11 3/4" x 35 5/8" (299 x 905)	13" x 36 7/8" (330 x 937)
PH810-4SPB-****-†		18 1/4" x 22 1/2" (464 x 572)	19 1/2" x 22 1/2" (495 x 572)

\* Specify -DL and/or required filter      Junction box location shown

† Specify Ceiling Condition

-T Non-insulated. 200W maximum lamp in distributing lens compartment. Thermal protection provided.

-IC Insulated. 40W maximum lamp in distributing lens compartment.

## Options

**Stainless Steel:** Provides stainless steel housing and trim for surface models; trim for recessed models. Add suffix -N.

**Distributing Lens:** Clear prismatic lens in one compartment for general illumination.

Add suffix -DL.

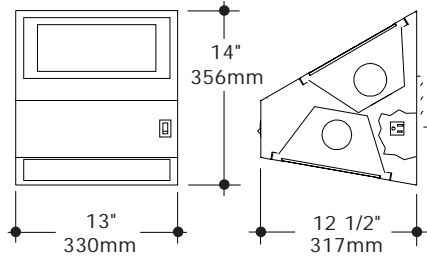
**Larger Size:** Fixtures with 10 x 12 filters.

Dimensions are proportionately larger.

Substitute **1012** for **810** in catalog number.

## Darkroom Safelites \ Warning Signs

### WALL



Shown with optional Rocker Switch **-SW**  
and Convenience Outlet **-CO**

Catalog Number

PHB-810-(filter number)

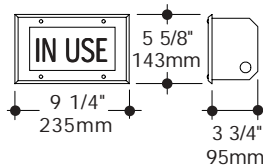
#### Options

**Convenience Outlet:** Add suffix **-CO**.

**Rocker Switch:** 3-way (up/off/down). Add suffix **-SW**.

### WARNING SIGNS

See complete line in Directional Signs section.



Catalog Number

S252-IN USE

**Construction:** 18 gauge steel, aluminum paint. Red letters on white.

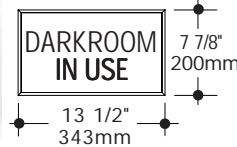
**Electrical:** One 25W A19 medium base incandescent

**Mounting:** Recessed housing has flanges with holes for mounting.

#### Options

**Stainless steel faceplate:** Add suffix **-N**.

**Fluorescent:** One 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.



Catalog Number

S193-DARKROOM IN USE

**Construction:** Extruded and formed aluminum, satin finish with clear anodize. Red letters on white.

**Electrical:** Two 25W T6½ intermediate base incand.

**Mounting:** Surface housing mounts to junction box

#### Options

**Bracket Mounting:** Ceiling: **-C**; End: **-LE** or **-RE**.

**Recessed Mounting:** Specify **S191**.

**Fluorescent:** Two 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.

## Darkroom Safelites

#### Specifications

#### Construction

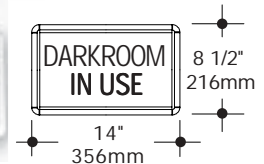
- Fixture is 20 gauge steel with black enamel finish
- Diffuser in general illumination uplite compartment is clear prismatic glass
- 8" x 10" Eastman Kodak filter is provided in downlite compartment
- UL/cUL listed

#### Electrical

- Uplite is wired for one 150W incandescent lamp
- Downlite filter compartment is wired for one 15W incandescent lamp
- Each compartment is to be individually switched
- 120V only

#### Mounting

- Fixture mounts to recessed junction box in wall.



Catalog Number

S130A-A14

**Construction:** Die-cast and extruded aluminum with white polyester coating. Red letters on white.

**Electrical:** Two 25W T6½ intermediate base incand.

**Mounting:** Surface housing mounts to junction box

#### Options

**Bracket Mounting:** Ceiling: **-C**; End: **-LE** or **-RE**.

**Fluorescent:** Two 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.

#### Eastman Kodak Safelight Filters

Number	Color	Material Usage
OA	Greenish Yellow	Black-and-white contact and duplicating materials and projection films
OC	Light Amber	Contact and enlarging papers
1	Red	Blue-sensitive materials and most photo-typesetting materials
1A	Light Red	Slow orthochromatic materials
2	Dark Red	Fast orthochromatic materials, green-sensitive x-ray films
3	Dark Green	Some panchromatic materials
6B	Brown	Blue-sensitive x-ray films
8	Dark Yellow	Color print and color intermediate motion picture films
10	Dark Amber	Color negative papers, materials, panchromatic black-and-white papers
13	Amber	Color negative papers, panchromatic black-and-white papers
GBX		Most blue-sensitive x-ray films, most green-sensitive medical x-ray films

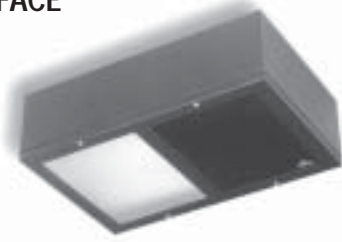
**COLE**  
Lighting

C. W. Cole & Company, Inc.  
2560 N. Rosemead Boulevard  
South El Monte, CA 91733-1593

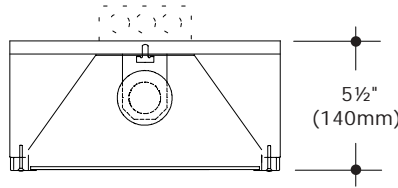
Fax (626) 443-9253  
Tel. (626) 443-2473  
info@colelighting.com

## Darkroom Safelites

## SURFACE



Shown with Distributing Lens -DL  
in one compartment



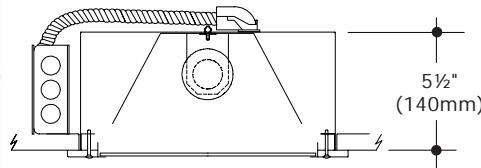
Catalog Numbers	Configuration	Dimensions
PH810-S-*		11 3/4" x 9 3/4" (299mm x 248mm)
PH810-2S-**-*		11 3/4" x 18 1/4" (299mm x 464mm)
PH810-3S-***-*		11 3/4" x 27 3/8" (299mm x 695mm)
PH810-4S-****-*		11 3/4" x 35 5/8" (299mm x 905mm)
PH810-S4S-****-*		18 1/4" x 22 1/2" (464mm x 572mm)

\* Specify -DL and/or required filter      Feed location shown

## RECESSED



Shown with Distributing Lens -DL  
in one compartment



Catalog Numbers	Configuration	Dimensions	
		Housing	Trim
PH810-PB-*-†		11 3/4" x 9 3/4" (299 x 248)	13" x 10 7/8" (330 x 276)
PH810-2PB-**-†		11 3/4" x 18 1/4" (299 x 464)	13" x 19 1/2" (330 x 495)
PH810-3PB-***-†		11 3/4" x 27 3/8" (299 x 695)	13" x 28 5/8" (330 x 727)
PH810-4PB-****-†		11 3/4" x 35 5/8" (299 x 905)	13" x 36 7/8" (330 x 937)
PH810-4SPB-****-†		18 1/4" x 22 1/2" (464 x 572)	19 1/2" x 22 1/2" (495 x 572)

\* Specify -DL and/or required filter      Junction box location shown

† Specify Ceiling Condition

-T Non-insulated. 200W maximum lamp in distributing lens compartment. Thermal protection provided.

-IC Insulated. 40W maximum lamp in distributing lens compartment.

## Options

**Stainless Steel:** Provides stainless steel housing and trim for surface models; trim for recessed models. Add suffix -N.

**Distributing Lens:** Clear prismatic lens in one compartment for general illumination.

Add suffix -DL.

**Larger Size:** Fixtures with 10 x 12 filters.

Dimensions are proportionately larger.

Substitute **1012** for **810** in catalog number.

## Description

Darkroom Safelites are task lighting fixtures required wherever photographic or X-ray film processing is performed. Filters must be selected to meet the requirements of the particular type of film that will be exposed to the light. Multiple-compartment fixtures allow safe processing of different types of film. Stainless steel construction for exposed surfaces is available for rooms with a corrosive atmosphere.

## Construction

- Housing and trim are 20 gauge steel
- Standard finish on surface models and trim of recessed models is black enamel
- Recessed housing has white polyester coating
- Trim is fully gasketed to insure light-tight compartments
- Plaster frame with attached junction box is provided for recessed models
- One 8" x 10" Eastman Kodak filter is provided for each compartment
- UL/cUL listed

## Electrical

- Wired for one medium base 120V incandescent lamp in each compartment
- Each compartment is to be individually switched
- Lamps over 15W are not recommended in filter compartments
- 75W maximum in distributing lens compartment in surface models
- Maximum lamp wattage in recessed models varies with ceiling condition

## To Specify

- Select catalog number.
- Add filter number and/or -DL for each compartment of model selected. Refer to filter data on back of this page.
- For recessed models, add appropriate suffix (-T or -IC) for ceiling condition.
- Add suffixes for options required to meet job conditions.



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South El Monte, CA 91733-1593

Fax (626) 443-9253

Tel. (626) 443-2473

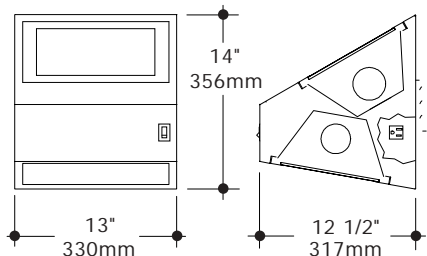
info@colelighting.com

www.colelighting.com



## Darkroom Safelites \ Warning Signs

### WALL



Shown with optional Rocker Switch **-SW**  
and Convenience Outlet **-CO**

Catalog Number

PHB-810-(filter number)

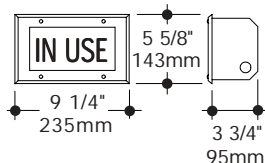
#### Options

**Convenience Outlet:** Add suffix **-CO**.

**Rocker Switch:** 3-way (up/off/down). Add suffix **-SW**.

### WARNING SIGNS

See complete line in Directional Signs section.



Catalog Number

S252-IN USE

**Construction:** 18 gauge steel, aluminum paint. Red letters on white.

**Electrical:** One 25W A19 medium base incandescent

**Mounting:** Recessed housing has flanges with holes for mounting.

#### Options

**Stainless steel faceplate:** Add suffix **-N**.

**Fluorescent:** One 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.



Catalog Number

S193-DARKROOM IN USE

**Construction:** Extruded and formed aluminum, satin finish with clear anodize. Red letters on white.

**Electrical:** Two 25W T6½ intermediate base incand.

**Mounting:** Surface housing mounts to junction box

#### Options

**Bracket Mounting:** Ceiling: **-C**; End: **-LE** or **-RE**.

**Recessed Mounting:** Specify **S191**.

**Fluorescent:** Two 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.



Catalog Number

S130A-A14

**Construction:** Die-cast and extruded aluminum with white polyester coating. Red letters on white.

**Electrical:** Two 25W T6½ intermediate base incand.

**Mounting:** Surface housing mounts to junction box

#### Options

**Bracket Mounting:** Ceiling: **-C**; End: **-LE** or **-RE**.

**Fluorescent:** Two 7W (G23 base) compact fluorescent. 120V standard. Add suffix **-F**.

### Eastman Kodak Safelight Filters

Number	Color	Material Usage
OA	Greenish Yellow	Black-and-white contact and duplicating materials and projection films
OC	Light Amber	Contact and enlarging papers
1	Red	Blue-sensitive materials and most photo-typesetting materials
1A	Light Red	Slow orthochromatic materials
2	Dark Red	Fast orthochromatic materials, green-sensitive x-ray films
3	Dark Green	Some panchromatic materials
6B	Brown	Blue-sensitive x-ray films
8	Dark Yellow	Color print and color intermediate motion picture films
10	Dark Amber	Color negative papers, materials, panchromatic black-and-white papers
13	Amber	Color negative papers, panchromatic black-and-white papers
GBX		Most blue-sensitive x-ray films, most green-sensitive medical x-ray films

## Darkroom Safelites

#### Specifications

#### Construction

- Fixture is 20 gauge steel with black enamel finish
- Diffuser in general illumination uplite compartment is clear prismatic glass
- 8" x 10" Eastman Kodak filter is provided in downlite compartment
- UL/cUL listed

#### Electrical

- Uplite is wired for one 150W incandescent lamp
- Downlite filter compartment is wired for one 15W incandescent lamp
- Each compartment is to be individually switched
- 120V only

#### Mounting

- Fixture mounts to recessed junction box in wall.

**COLE**  
Lighting

C. W. Cole & Company, Inc.  
2560 N. Rosemead Boulevard  
South El Monte, CA 91733-1593

Fax (626) 443-9253  
Tel. (626) 443-2473  
info@colelighting.com

**DESCRIPTION**

Showerlight for use with 5" ET500 All Pro incandescent housings and H570 Halo compact fluorescent housing family. Showerlight trim with gasketed non-conductive corrosion-resistant polymer trim ring. Clear fresnel lens. UL/cUL Wet Location listed for use in showers.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		DS
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**DESIGN FEATURES**

Torsion springs pull trim tight to ceiling. Showerlight trim with gasketed non-conductive corrosion-resistant polymer trim ring. Clear fresnel lens.



**ERT552**  
High Gloss Appliance White  
Trim Ring  
with Fresnel Lens

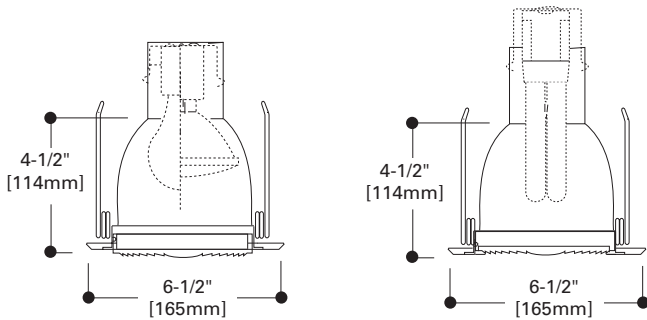
ERT552

5" Lens  
Showerlight



**LAMP LISTINGS**

ET500 ET500R	60W A19, 50W PAR30, 50W PAR30L, 65W BR30
EI500AT EI500RAT	35W PAR30L
H570ICAT H570RICAT	13W DTT, 13W TTT compact fluorescent lamps
H571ICAT H571RICAT	18W DTT, 18W TTT compact fluorescent lamps
H572ICAT H572RICAT	26W TTT compact fluorescent lamps



Trim



ERT552= 5" Glass Fresnel  
Lens Shower Trim

Finish



PS=High Gloss Appliance White Trim  
Ring - wet locations listed for use in  
showers

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)

**DESCRIPTION**

Low brightness 7-3/8" aperture wall wash for use with (2)18W or 26W Quad Tube 4-pin compact fluorescent lamps. The geometric stepped reflector maximizes flux towards the wall and is spectrally neutral leaving the color temperature and the color rendering of the source unchanged. It is available in single and double wall wash versions. Optics offer unparalleled performance with uniform luminance on wall, no flashback, and glare free downlighting. Open downlight, lens, and open wall wash trims are interchangeable within the same housing

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		DW
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**A ... Reflector**

Injection molded Geometric Reflector for Uniform Vertical Illumination is vacuum metallized with polysiloxane hardcoat finish. One piece spun parabolic downlight reflector, .050 thick aluminum, available in a variety of Alzak® finishes.

**B ... Trim Ring Options**

Self flanged or molded white trim ring. Rimless or metal trim ring accessories available.

**C ... Socket Connector**

One piece die cast aluminum connection allows venting for maximum thermal performance.

**D ... Housing Mounting Frame**

One piece precision die cast aluminum 1-1/2" deep collar accommodates varying dimensions of ceiling materials.

**E ... Universal Mounting Bracket**

Accepts 1/2" EMT, C Channel, T bar fasteners, and bar hangers. Adjusts 5" vertically from above or below ceiling.

**F ... Conduit Fittings**

Die cast screw tight connectors.

**G ... Junction Box**

Listed for eight #12AWG (four in, four out) 90°C conductors feed through branch wiring.

1/2" and two 3/4" pry outs. Positioned to allow straight conduit runs. Access to junction box by removing reflector.

**H ... Socket**

26W lamps: 4-pin G24q3.  
18W lamps: 4-pin G24q2 base.  
Bases have fatigue free stainless steel lamp spring to ensure positive lamp retention.

**I ... Ballasts**

Electronic ballast provides full light output and rated lamp life. Provides flicker free and noise free operation and starting. End of lamp life protection is standard.

**Labels**

cULus listed, C.S.A. certified, standard damp label, IBEW union made.



**C7218, C7226**  
**7211/7210**  
**7221/7220**

**(2) 18W, 26W Quad Compact Fluorescent**

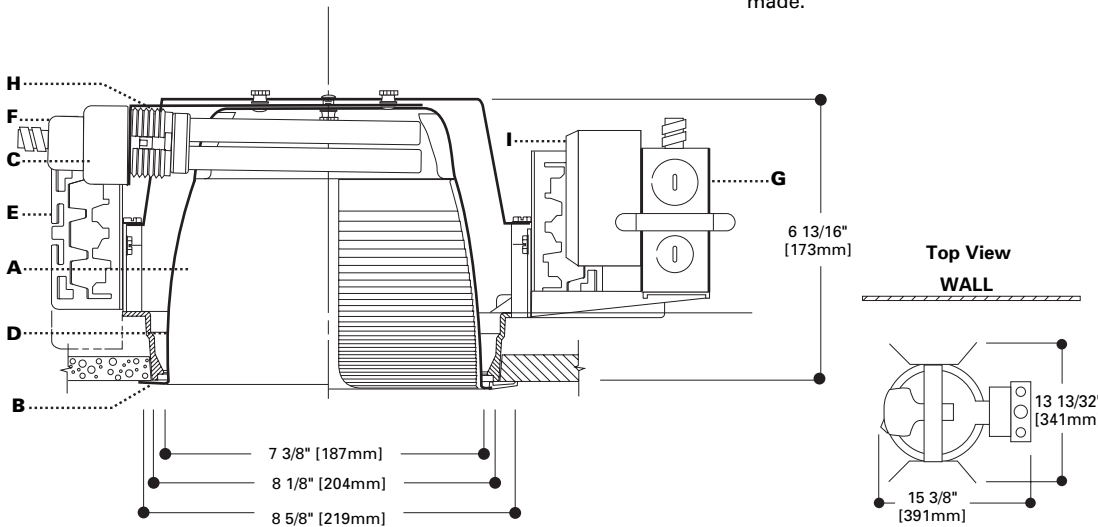
**7-3/8" OPEN WALL WASH**

**Energy Data**

(2) 26W Quad 4-pin  
Ballast: Electronic  
120V input watts: 50, Line Amps: 0.45  
277V Input Watts: 50, Line Amps: 0.20  
Power Factor: >.99, THD: <10%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

(2) 18W Quad 4-pin  
WALL  
Ballast: Electronic  
120V input watts: 37, Line Amps: 0.32  
277V Input Watts: 37, Line Amps: 0.14  
Power Factor: >.99, THD: <20%  
Min. Starting Temp.: -10°C (15°F)  
Sound Rating: A

**NOTES:**  
Accessories should be ordered separately. For additional options, please consult your Cooper Lighting Representative. Alzak is a registered trademark of Aluminum Company of America. Hi-Lume is a registered trademark of Lutron Co., Inc.



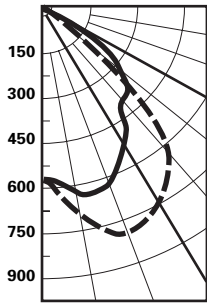
**ORDERING INFORMATION**

Sample Number: Complete unit consists of housing, ballast and trim.

<b>Housing</b> C7: 7" Horizontal Lamp	<b>Ballast</b> E: 120/277V 50/60 Hz Electronic 3E: 347V 50/60 Hz Electronic 1D: 120V Dimming Ballast 2D: 277V Dimming Ballast	<b>Options</b> CP: Chicago Plenum EM: Emergency Module with remote test switch 2C: (2) ballasts for Hi-Low Switching 2CMS: 2 Circuit Master Satellite (2 housings, order 2 trims)	<b>Trims</b> 7211: Single W W, Self Flanged 7210: Single WW, Molded Trim Ring 7221: Double W W, Self Flanged 7220: Double W W, Molded Trim Ring	<b>Finish</b> LF: Low Iridescent Clear H: Haze WHH: Warm Haze G: Gold WH: Wheat W: Gloss White GP: Graphite GPH: Graphite Haze K: Cognac KH: Cognac Haze	<b>Option</b> WF: White Painted Flanged (Self Flanged only)	<b>Accessories</b> HB26: C Channel Bar Hangers, 26" Long, Pair HB50: C Channel Bar Hangers, 50" Long, Pair TRM7: Metal Trim Ring, Specify Finish TRR7: Rimless Trim Ring, White FK5: 5 Amp Field Installable Fuse Kit 300V Max DT7: Deco Trims RMB-22: Wood Joist Bar Hanger, 22" Long, Pair
<b>Number of Lamps</b> 2: 2 Lamps						
<b>Wattage</b> 18: 18W DTT Lamp 26: 26W DTT Lamp						



**Candlepower Distribution**



Test No. H23194  
**C7218-7210LI**  
 Wall Wash /  
 Downlight  
 Lamp=(2) 18DTT  
 Lumens=1250 Each  
 Efficiency=59.0%

0°  
 180°

**Candlepower**

Deg.	0° Wall	180° Dwnlt
0	559	559
5	558	602
15	614	730
25	585	755
35	489	667
45	378	486
55	297	148
65	148	5
75	57	2
85	12	0
90	0	0

**Average Luminance CD/SQ M**

Deg.	0° Wall	180° Dwnlt
45	19364	24934
55	18775	9327
65	12736	446
75	8016	266
85	4994	0

**Single Fixture 2'6" From Wall**

DD	Distance From Fixture Along Wall					
	1'	2'	3'	4'	5'	6'
1	15	10	4	1	0	0
2	28	21	9	3	1	0
3	17	16	12	6	2	1
4	13	11	9	6	4	2
5	8	8	6	5	3	2
6	6	5	5	4	3	2
7	4	4	3	3	2	2
8	3	3	2	2	2	1
9	2	2	2	2	1	1
10	1	1	1	1	1	1

**2'6" Distance From Wall**

DD	Spacing Between Fixtures					
	3'			4'		
1	18	14	18	16	8	16
2	34	30	34	30	18	30
3	30	30	30	22	25	22
4	25	25	25	20	18	20
5	19	20	19	15	15	15
6	14	15	14	12	12	12
7	11	11	11	9	9	9
8	8	8	8	7	7	7
9	6	6	6	5	6	5
10	5	5	5	4	4	4

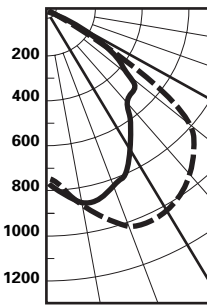
**3' Distance From Wall**

DD	Spacing Between Fixtures					
	3'			4'		
1	11	9	11	9	6	9
2	24	21	24	20	14	20
3	26	28	26	19	22	19
4	24	23	24	18	17	18
5	19	20	19	16	15	16
6	15	15	15	12	13	12
7	12	12	12	10	10	10
8	9	9	9	8	8	8
9	7	7	7	6	6	6
10	6	6	6	5	5	5

**4' Distance From Wall**

DD	Spacing Between Fixtures					
	4'			6'		
1	4	3	4	3	2	3
2	10	9	10	8	5	8
3	15	14	15	12	7	12
4	15	16	15	10	11	10
5	14	13	14	9	10	9
6	12	12	12	9	8	9
7	10	11	10	8	7	8
8	8	9	8	6	6	6
9	7	7	7	5	5	5
10	6	6	6	4	5	4

**Candlepower Distribution**



Test No. H23186  
**C7226-7210LI**  
 Wall Wash /  
 Downlight  
 Lamp=(2) 26DTT  
 Lumens=1800 Each  
 Efficiency=60.2%

0°  
 180°

**Candlepower**

Deg.	0° Wall	180° Dwnlt
0	784	784
5	788	850
15	909	1018
25	893	1028
35	752	895
45	573	723
55	437	229
65	225	9
75	80	4
85	16	1
90	0	0

**Average Luminance CD/SQ M**

Deg.	0° Wall	180° Dwnlt
45	29392	37086
55	27634	14481
65	19310	772
75	11211	561
85	6659	416

**Single Fixture 2'6" From Wall**

DD	Distance From Fixture Along Wall					
	1'	2'	3'	4'	5'	6'
1	22	15	6	2	1	0
2	40	32	13	6	2	1
3	27	24	18	10	3	1
4	19	17	14	9	6	2
5	13	12	10	7	5	3
6	8	8	7	6	4	3
7	6	6	5	4	4	3
8	4	4	4	3	3	2
9	3	3	3	2	2	2
10	2	2	2	2	2	1

**2'6" Distance From Wall**

DD	Spacing Between Fixtures					
	3'			4'		
1	26	20	26	24	12	24
2	50	46	50	44	27	44
3	46	46	46	33	38	33
4	39	39	39	31	29	31
5	29	30	29	23	23	23
6	22	23	22	18	19	18
7	16	17	16	14	14	14
8	12	13	12	10	11	10
9	9	9	9	8	8	8
10	7	7	7	6	7	6

**3' Distance From Wall**

DD	Spacing Between Fixtures					
	3'			4'		
1	15	14	15	13	9	13
2	35	32	35	30	21	30
3	39	42	39	29	34	29
4	37	36	37	28	27	28
5	30	31	30	24	23	24
6	23	24	23	19	19	19
7	18	18	18	15	16	15
8	14	14	14	12	12	12
9	11	11	11	9	10	9
10	8	8	8	7	8	7

**4' Distance From Wall**

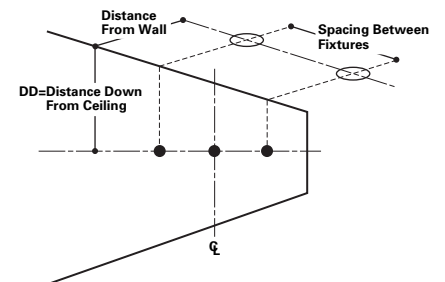
DD	Spacing Between Fixtures					
	4'			6'		
1	6	5	6	4	3	4
2	15	14	15	12	7	12
3	22	21	22	17	11	17
4	22	24	22	15	16	15
5	22	21	22	14	15	14
6	19	19	19	13	13	13
7	16	16	16	12	11	12
8	13	13	13	10	10	10
9	11	11	11	8	8	8
10	9	9	9	7	7	7

**Notes:**

- Illuminance values for multiple fixtures are based upon the center two units of a four unit array. Footcandle values are centerline of fixtures and centered between fixtures.
- Illuminance values are cosine corrected initial values with no contribution from inter reflections from other room surfaces. Total illumination may increase from contributions from other surfaces.
- Changing fixture spacing will affect illuminance level.

$$\text{New Fc} = \frac{\text{Existing Spacing}}{\text{New Spacing}} \times \text{Average Table Fc Level}$$

- When selecting colored cones option, only downlight cone is colored; the wall wash reflector is specular clear. This allows the color (CRI, °K) of the light source to be unaffected and maximizes lumen output.



# COOPER LIGHTING - SURE-LITES®

## DESCRIPTION

The Sure-Lites CU1 unit represents the next generation of emergency lighting. Sure-Lites has combined its dependable performance with a visually pleasing design. The PRESTO(TM) unit is designed to harmonize with today's decor in commercial and public spaces. Long-life battery and solid-state engineering provide trouble-free operation. Two 5.4W wedge base incandescent lamps in locking specular reflectors appear to float in clear acrylic domes for distortion-free lighting. PRESTO(TM) is "contractor-friendly". The unique wiring module makes installation a snap. PRESTO(TM) may be ceiling or wall mounted, horizontally or vertically.

Catalog #		Type
Project		E
Comments		Date
Prepared by		

## SPECIFICATION FEATURES

### Electronic

- Dual Voltage Input 120/277 VAC, 60 Hz, Isolation Transformer
- Line-latching
- Solid-state Voltage Limited Charger
- Solid-state Switching
- Low-Voltage Disconnect
- Brownout Circuit
- Overload/Short Circuit Protection
- Test Switch/Power Indicator Light

### Code Compliance

- UL 924 Listed
- Life Safety NFPA 101
- NEC/OSHA
- Most State and Local Codes

### Head/Lamp Data

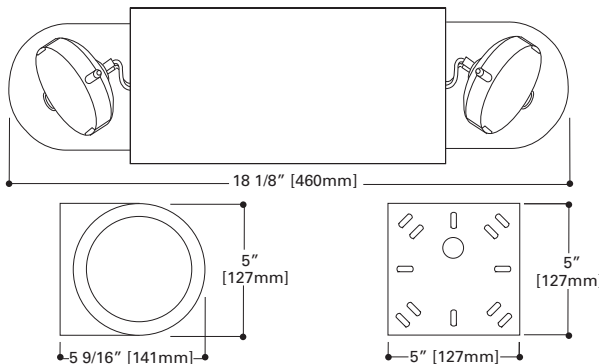
- Clear Acrylic Domes for Distortion-free Lighting
- Optional Vandal Resistant, Polycarbonate Domes
- Fully Adjustable, Locking
- Diffusing Lens Cover Eliminates Glare
- Remote Capability

### Battery

- Sealed Lead Calcium, Recombination
- Maintenance-free, Long-life
- Full Recharge Time: CU-1: 24 hrs. (max.) CU-1-HD: 48 hrs. (max.)
- Polarized Battery Terminals

### Housing Construction

- Injection Molded, High Impact Plastic
- Knockout for Surface Mounted Conduit
- Polarized Wiring Module
- Universal J-Box Mounting Pattern
- Tether Straps for Easy Installation
- White Finish Standard, Optional Black Finish



## CU SERIES

THERMOPLASTIC

SEALED LEAD CALCIUM BATTERY

EMERGENCY LIGHTING

## ELECTRICAL RATINGS

### Rated Wattage to 87 1/2% of Rated D.C. Voltage

Model	DC Voltage	1 1/2 Hours	2 Hours	3 Hours
CU1	6	10.8	7.2	-
CU1HD	6	22	16	11
CU1347	6	10.8	7.2	-
CU1HD347	6	22	16	11

### Lamp Information

Type	Wattage	Number
Incandescent	5.4	29-121
Incandescent	5.4	29-121
Incandescent	5.4	29-121
Incandescent	5.4	29-121



## ORDERING INFORMATION

<b>Series</b> CU1 CU1HD CU1347 CU1HD347	<b>Options</b> <sup>1, 2, 3</sup> B= Black Finish PCL= Polycarbonate Domes SD= Self Diagnostics	<b>Accessories</b> <sup>4</sup> Protective Housing WG19= Wire Guard VS1= Polycarbonate Vandal Shield VS1WP= Polycarbonate Vandal Shield - Weatherproof
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Notes: 1 Add as a suffix. 2 Alternate Lamps, Head Types, No Head, Multiple Heads and other options. Consult your Cooper Lighting Representative. 3 Wedge base and krypton lamps only. 4 Order separately. \* 347 = 347V for Canada.

## ENERGY DATA

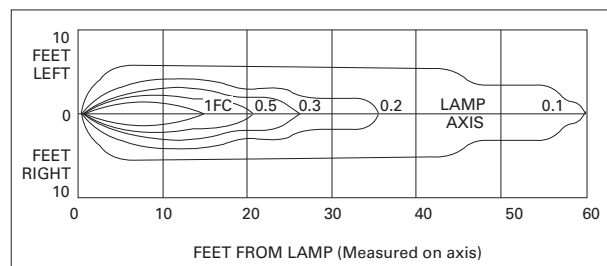
Input Current (Max.):  
CU1, CU1HD  
120V=.12A  
277V=.05A

CU1347(2)  
120V=.14A  
347V=.06A

CU1HD347(2)  
120V=.18A  
.347V=.07A

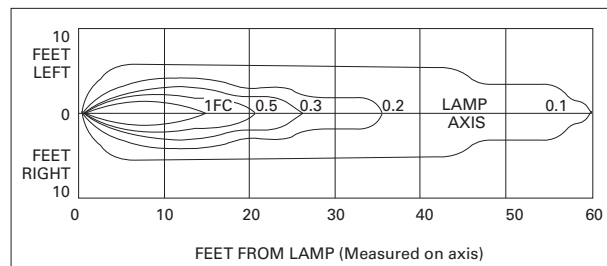
## PHOTOMETRICS

## Horizontal Distribution



Lamp No. 29-121  
Initial Lumens – 29-121 @ 75

## Vertical Distribution



Lamp No. 29-121

## TECHNICAL DATA

**Lamps**

Two 5.4W wedge base incandescent lamps in specular reflectors with diffusing lens cover. Lamps and reflector assembly may be adjusted 180° horizontally and 180° vertically. Ratcheting washer and serrated dome provide positive lamp aiming.

**Housing**

Injection molded high impact housing in white or optional black finish. Separate wiring module installs to junction box – no need to juggle housing in position while making AC connections. Wiring module connects to housing with polarized plug. Tether straps support housing in position for future maintenance. Clear domes, made of standard acrylic or optional vandal resistant polycarbonate, provide distortion free lighting. Knockouts provided for surface conduit mounting. PRESTO may be wall or ceiling mounted horizontally or vertically.

**Line-Latched**

Sure-Lites' line-latched electronic circuitry makes installation easy and economical. A labor efficient AC-activated load switch prevents the lamps from turning on during installation to a non-energized AC circuit. Line-latching eliminates the need for a contractor's return to a job site to connect the batteries when the building's main power is permanently turned on.

**Solid-State Charger**

Supplied with a 120/277 VAC, voltage regulated solid-state charger. Immediately upon restoration of AC current after a power failure, the charger provides a high charge rate. The charge circuit reacts to the condition of the battery and alters the rate of charge in order to maintain peak battery capacity and maximize battery life. Solid-state construction recharges the battery following a power failure in accordance with UL 924.

**Overload and Short-Circuit Protection**

The solid-state overload monitoring device in the DC circuit disconnects the lamp load from the battery should excessive wattage demands be made and automatically resets when the overload or short circuit is removed. This overload current protective feature eliminates the need for fuses or circuit breakers for the DC load.

**Brownout Circuit**

The brownout circuit in Sure-Lites' units monitors the flow of AC current to the unit and activates the emergency lighting system when a predetermined reduction of AC power occurs. This dip in voltage will cause most ballasted fixtures to extinguish causing loss of normal lighting even though a total power failure has not occurred.

**Solid-State Transfer**

The unit incorporates a solidstate switching transistor which eliminates corroded and pitted contacts or mechanical failures associated with relays. The switching circuit is designed to detect a loss of AC voltage and automatically

energizes the lamps. Upon restoration of the AC power, the emergency lamps will switch off and the charger will automatically recharge the battery.

**Low-Voltage Disconnect**

When the battery's terminal voltage falls below 80% of the rated voltage, the low-voltage circuitry disconnects the lighting load. The disconnect remains in effect until normal utility power is restored, preventing deep battery discharge.

**Test Switch/Power Indicator Light**

Conveniently located combination Test Switch/Power Indicator Light allows for manual verification of proper operation of the transfer circuit and emergency lamps.

**Sealed Lead Calcium Battery**

The fully sealed, long-life, maintenance-free lead calcium battery is ideal for emergency lighting applications. These recombinant cycle batteries typically provide eight to ten years of life and may be operated in any position.

**Warranty**

All Sure-Lite' units are backed by a firm one-year warranty against defect in material and workmanship (excluding lamps). Maintenance-free, long-life, sealed lead calcium batteries carry a five-year pro-rata warranty.

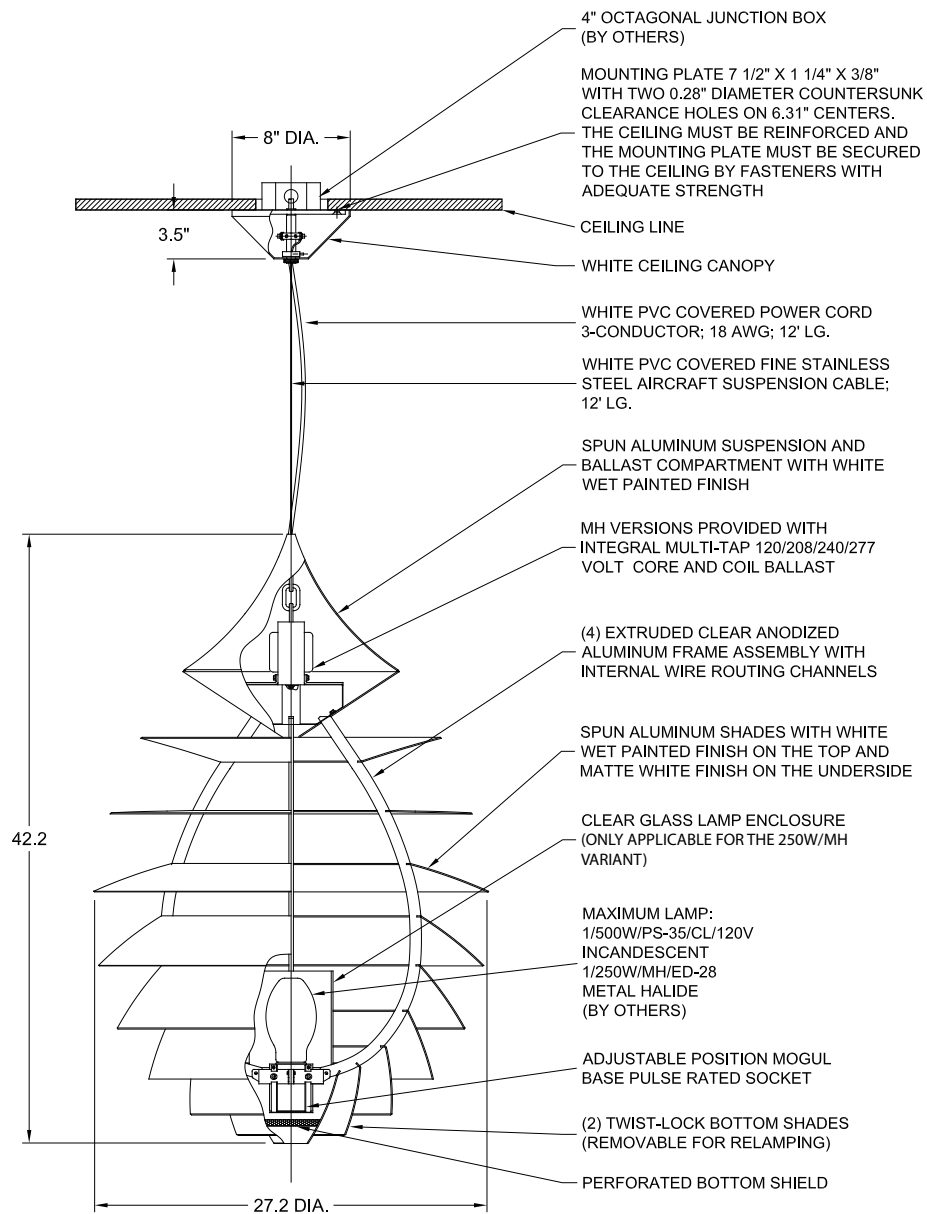
# LP Centrum

Design: Kurt Nørregaard, Poul Henningsen

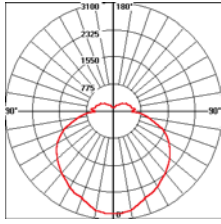
Type:

Project:

Catalog Number:



# LP Centrum



Photometric Report: LPC-1-250W-MH-ED28.IES  
 Report No.: ITL37786  
 Poulsen Report No.: LPC-1-250W-MH-ED28.IES  
 Luminaire: LP Centrum, White  
 Lamp: 1/250W/MH  
 Efficiency: 61.2%  
 Description: All data shown are per 22000 lumens. This report can be used for calculation on all versions LPC-349,352,365and 378. Use only actual lumen data when calculating

Candlepower Distribution

Vertical Angle	Candela
0	2926
5	2926
10	2882
25	2596
40	2310
55	1980
70	1496
85	792
90	528
120	418
150	176
180	88

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0-30	2251	10.2	16.7
0-40	3759	17.1	27.9
0-60	7240	32.9	53.8
0-90	11063	50.3	82.2
90-120	1614	7.3	12.0
90-130	1940	8.8	14.4
90-150	2290	10.4	17.0
90-180	2392	10.9	17.8
0-180	13455	61.2	100.0

Coefficients of Utilization - Zonal Cavity Method  
Effective Floor Cavity Reflectance 20%

Ceiling Reflectance (%)	80				70				50				30				10				0
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0			
Room Cavity Ratio	0	70	70	70	70	67	67	67	67	62	62	62	57	57	57	52	52	52	50		
1	62	59	55	53	59	56	53	51	52	49	47	47	45	44	43	42	41	38			
2	56	50	45	41	53	48	44	40	44	40	37	40	37	35	37	35	33	31			
3	50	43	38	33	48	41	37	32	38	34	30	35	32	29	32	29	27	25			
4	46	38	32	28	43	36	31	27	34	29	25	31	27	24	28	25	22	21			
5	42	34	28	24	40	32	27	23	30	25	22	27	23	20	25	22	19	18			
6	38	30	24	20	37	29	24	20	27	22	19	25	21	18	23	19	17	15			
7	36	27	22	18	34	26	21	17	24	20	16	22	18	15	20	17	15	13			
8	33	25	19	16	32	24	19	15	22	18	14	20	17	14	19	16	13	12			
9	31	22	17	14	29	22	17	14	20	16	13	19	15	12	17	14	12	10			
10	29	21	16	12	28	20	15	12	19	14	12	17	14	11	16	13	11	9			

## Design

Kurt Nørregaard, Poul Henningsen

## Concept

The fixture provides 100% glare-free light. Its geometric design is based according to the mathematical lituus curve. All the illuminated surfaces are hit by the light at the same angle, casting the light into the room under the same conditions. This results in both horizontal and vertical light emission.

## Finish

White, wet painted.

## Material

Shades: Spun aluminum. Frame: Extruded, anodized aluminum. Suspension: Spun aluminum.

## Mounting

Suspension type: 1x PVC covered stainless steel aircraft cable. Suspension length: 12'. Canopy: White. Cord type: 3-conductor, 18 AWG white PVC power cord. Cord length: 12'.

## Weight

Max. 38 lbs.

## Label

cULus, Dry location. IBEW.

Product code	Light source	Voltage	Finish
LPC	1/250W/MH/ED-28 mogul 1/500W/PS-35/CL mogul	120/208/240/277V 120V	WHT

## Specification notes:

- a. MH variants provided with 120/208/240/277V integral core and coil ballast.  
 b. Incandescent variants only available in 120V.

## Info notes:

- I. The comparable EU version has the following classification: Ingress Protection Code: IP20.



Ovation Pendant 

**DESCRIPTION**

Hand pulled glass shade, richly layered in brilliant color, with machined top or glass ball detail suspended from a round canopy. Black, satin nickel, and white canopy options include satin nickel top detail and clear cable; antique bronze includes antique bronze detail and brown cable. Handmade wrought iron wrap accessory sold separately below. Includes 120 volt, 75 watt A19mediumbase lamp or 18 watt GX24Q-2 base triple tube compact fluorescent lamp (electronic ballast included). Fixture is provided with six feet of field-cuttable cable. Incandescent version dimmable with standard incandescent dimmer.

**INSTALLATION**

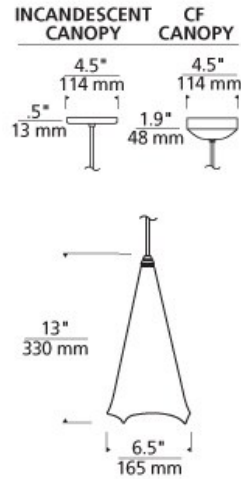
This product can mount to either a 4" square electrical box with round plaster ring or an octagon electrical box.

**WEIGHT**

3.3lb / 1.5kg ±



ferrari red



**COLOR OPTIONS**



ferrari red    tahoe pine amber    tortoise shell    white frit

**ORDERING INFORMATION**

700 SYSTEM	OVP	COLOR	Glass Ball Color	FINISH	LAMP
TD	LINE-VOLTAGE PENDANTS	<b>R</b> FERRARI RED <b>A</b> TAHOE PINE AMBER <b>T</b> TORTOISE SHELL <b>W</b> WHITE FRIT	<b>AN</b> AMBER BALL <b>CN</b> CLEAR BALL <b>NN</b> NO BALL <b>RN</b> RED BALL	<b>Z</b> ANTIQUE BRONZE <b>B</b> BLACK <b>S</b> SATIN NICKEL <b>W</b> WHITE	INCANDESCENT 120V <b>-CF</b> COMPACT FLUORESCENT 120V <b>-CF277</b> COMPACT FLUORESCENT 277V

For use on Halo\*, Juno\* or Lightolier\* 120 volt single-circuit track, order as follows:

**Incandescent:** Order pendant as **700TD** and order appropriate [120V Track Adapter](#)

**Compact Fluorescent:** Substitute 700TD with one of the following: **700TH** (fits Halo\*), **700TJ** (fits Juno\*) or **700TI** (fits Lightolier\*) and by substituting the finish with one of the following: **BZ** (Black/Antique Bronze), **BS** (Black/Satin Nickel), **WZ** (White/Antique Bronze) or **WS** (White/Satin Nickel).

\*Tech Lighting is not affiliated, nor is it endorsed by any of the companies listed nor does Tech Lighting distribute any of their products.



700	___	OVP	___	___	___	___
FIXTURE TYPE: _____						
JOB NAME: _____						
NOTES: _____						
_____						
_____						

**Ovation Iron Wrap**

---

**DESCRIPTION**

Handmade wrought iron wrap to be used with the Ovation Pendant.



**ORDERING INFORMATION**

**700FJMOVLR FINISH**

---

- I BLACK IRON
- S SATIN NICKEL



**TECH LIGHTING®**

7400 Linder Avenue      T 847.410.4400  
Skokie, Illinois 60077      F 847.410.4500

[www.techlighting.com](http://www.techlighting.com)

700FJMOVLR \_\_\_\_\_

FIXTURE TYPE: \_\_\_\_\_

JOB NAME: \_\_\_\_\_

NOTES: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_



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**DESCRIPTION**

293 Luminous Double Ring features a soft halo of indirect illumination and is available in two sizes.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Material**

Aluminum or brass mounting pan and rings with a matte white acrylic diffuser.

**Finish**

Standard: Matte White (MW).  
Premium: Aluminum Paint (ALP), Gun Metal (GNM), Natural Aluminum (NA) [Sustainable Design], Lacquered Natural Aluminum (SAL), Polished Chrome (PC), Satin Chrome (SC), Satin Brass (SB), Polished Brass (PB), Satin Copper (SCP), Polished Copper (PCP), Oxidized Copper (OCP), Satin Nickel (SN), Polished Nickel (PN), Oxidized Brass (OBRS) or Custom Color (CC).

Custom Decorative Metals: (Specify a Color & Pattern) Colors - Clear (CLR), Cabernet (CBT), Sapphire (SPE), Sage (SGE), Brass (BRS), Copper (CRP), Black Pearl (BPL), Slate Green (SGN), Champagne (CMP), Chocolate (CLE), Indigo (IDO), Royal Blue (RBE), or Pewter (PWR).  
Patterns - Coral (COL), Seashell (SHL) or Smooth (SMT).  
Minimum quantity is 10 of one color/pattern. Contact the factory for lead-time.

**Optics**

Refer to www.shaperlighting.com for complete photometrics.

**Ballast**

Integral electronic HPF, multi-volt 120/277V (347V Canada), thermally protected with end-of-life circuitry to accommodate the specified lamp wattage.

**Lamp/Socket**

16": One (1) 22W or 40W T5 circular fluorescent lamp.  
22": One (1) 22W T5 circular fluorescent lamp and one (1) 40W T5 circular fluorescent lamp.  
Socket injection molded plastic. Lamps furnished by others.

**Installation**

Supplied with a universal circular strap for a standard 4" J-box or plaster ring. Shaper luminaires are designed for interior installations only.

**Options**

Hand Painted Faux Alabaster Bowl (FB), Hand Painted Faux Linen Bowl (LNB), Remote Emergency Ballast - Supplied by others (REM), Finial with Double Bar Trim (F2B), Damp Location (DL): All painted finishes only. Energy Star Rating - Contact

factory. Dimming available with 55WT5 - Contact factory.

**Labels**

U.L. and C.U.L approved for indoor and damp location. See options for damp location finishing requirements. Shaper's DL option is for interior applications (only) that have more than average moisture (i.e. bathroom, laundry room, etc.) but are not UL listed for pool, sauna, shower, whirlpool and any exterior applications (i.e. covered garage or building entrance) with exposure to weather elements such as rain, wind, etc.

**Modifications**

Shaper's skilled craftspeople with their depth of experience offer the designer the flexibility to modify standard surface luminaires for project specific solutions. Contact the factory regarding scale options, unique finishes, mounting, additional materials/colors, or decorative detailing.



**293 SERIES**

Surface Luminaire  
Luminous Double Ring  
Bowl



**New Custom  
Decorative Metals Finish**

**ORDERING INFORMATION**

Sample Number: 293-22-S-T5C/2/22/40-277V-PCP

<b>Series</b> 293=Double Ring Surface	<b>Size</b> 16" 22"	<b>Mounting Type</b> S = Surface	<b>Lamp</b> T5C/1/22 <sup>1</sup> T5C/1/40 <sup>1</sup> T5C/2/22/40 <sup>2</sup>	<b>Finish</b> <sup>3</sup> <u>Standard</u> MW=Matte White <u>Premium</u> ALP=Aluminum Paint CC=Custom Color GNM=Gun Metal NA=Natural Aluminum OBRS=Oxidized Brass OCP=Oxidized Copper PB=Polished Brass PC=Polished Chrome PCP=Polished Copper PN=Polished Nickel SAL=Lacquered Satin Aluminum SB=Satin Brass SC=Satin Chrome SCP=Satin Copper SN=Satin Nickel	<b>Finish</b> <sup>4</sup> (Custom Metals Only) <u>Colors</u> CLR=Clear CBT=Cabernet SPE=Sapphire SGE=Sage BRS=Brass CPR=Copper BPL=Pearl Black SGN=Slate Green CMP=Champagne CLE=Chocolate IDO=Indigo RBE=Royal Blue PWR=Pewter	<b>Options</b> DL=Damp Location <sup>6</sup> REM=Remote Emergency Ballast <sup>7</sup> F2B=Finial w/ Double Bar Trim FB=Hand Painted Faux Alabaster Bowl LNB=Hand Painted Faux Linen Bowl
			<b>Voltage</b> 120V 277V 347V	<b>Pattern</b> <sup>5</sup> COL=Coral SHL=Seashell SMT=Smooth		

**Notes:**

- <sup>1</sup> Available in 16".
- <sup>2</sup> Available in 22".
- <sup>3</sup> Leave blank if specifying Decorative Metals Finish.
- <sup>4</sup> Select a finish and pattern for Decorative Metals Finish.
- <sup>5</sup> Available in Customer Decorative Metals only.
- <sup>6</sup> Interior applications only.
- <sup>7</sup> Supplied by others.

**ARRA**

Shaper Lighting certifies that its products satisfy the requirements of Section 1605 of the American Recovery and Reinvestment Act (also known as the ARRA Buy American provision).

---

**SUSTAINABLE DESIGN**

Shaper has a long-standing history of offering environmentally-friendly fixtures. The copper and bronze alloys used in our exterior luminaires feature up to 98% recycled content, contribute less undesirable air emissions compared to painted aluminum and are easy to recycle.

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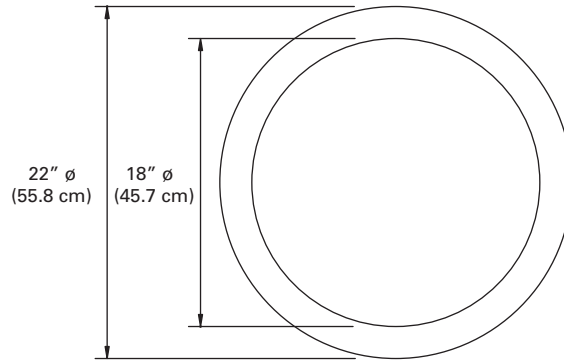
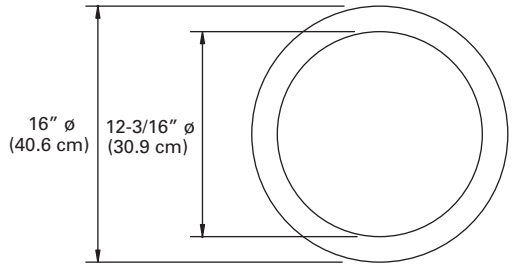
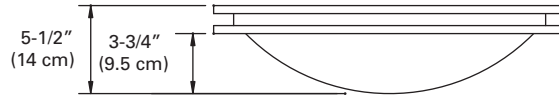
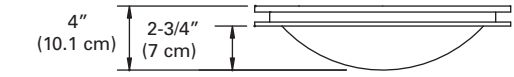
**QUICK SHIP (QS)**

Shaper's Quick Ship program features over thirty-four fixtures with finish options such as Satin Chrome, Natural Aluminum and Satin Brass, and a wide variety of lamp selections. All products ship in five days from receipt of order.

Refer to the Icon Legend  
Link on shaperlighting.com.



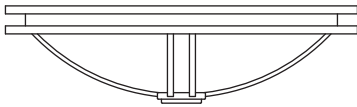
MOUNTING TYPE



293 - 16"  $\phi$  STANDARD

293 - 22"  $\phi$  STANDARD

OPTIONS



FINIAL WITH DOUBLE TRIM BAR (F2B)

COMPANION PRODUCTS



494-RP



494



693



693-WP

**Ovation Wall** 

**DESCRIPTION**

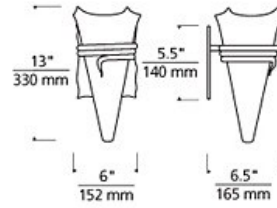
Hand pulled glass shade, richly layered in brilliant color, with handmade wrought iron base. Provides ambient and up-light. Includes 120 volt, 100 watt A19 medium base lamp or 18 watt GU24 base self-ballasted compact fluorescent lamp. Incandescent version dimmable with standard incandescent dimmer.

**INSTALLATION**

This product can mount to either a 4" square electrical box with round plaster ring or an octagonal electrical box (not included).

**WEIGHT**

6.3lb / 2.86kg ±



tahoe pine amber

**COLOR OPTIONS**



ferrari red



tahoe pine amber



tortoise shell



white frit

**ORDERING INFORMATION**

**700TDOVS COLOR**

- R FERRARI RED
- A TAHOE PINE AMBER
- T TORTOISE SHELL
- W WHITE FRIT

**FINISH**

- Z ANTIQUE BRONZE
- B BLACK IRON
- S SATIN NICKEL

**LAMP**

- INCANDESCENT 120V
- CF COMPACT FLUORESCENT 120V



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F 847.410.4500

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<p>700TDOVS _____</p> <p>FIXTURE TYPE: _____</p> <p>JOB NAME: _____</p> <p>NOTES: _____</p> <p>_____</p> <p>_____</p>
---



**DESCRIPTION**

Low brightness 9-1/2" aperture Surface Cylinder for use with (2)26W, 32W or 42W Triple Twin Tube 4-pin compact fluorescent lamps. Reflectors with different distributions may be used within the same housing for a variety of lighting effects. Standard features include low iridescent finish on all reflectors, electronic ballast and venting to ensure maximum lamp life and lumen output. Optics offer unparalleled performance with glare free downlighting.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		G5
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**A ... Reflector**

Available in a variety of Alzak® finishes, .050 thick aluminum, in a one piece spun parabolic contour. Positive reflector mounting, without tools, pulls trim tight to housing.

**B ... Housing**

Round seamless aluminum with crisply detailed edges. Choice of finish in white, matte black or bronze. Other finish options available upon request. Installs to canopy via keyhole slots for positive mounting.

**C ... Mounting**

Mounting canopy installs to recessed junction box (by others). All hardware and brackets are galvanized or plated.

**D ... Socket**

Two 4-pin Gx24q3 or Gx24q4 bases with fatigue free stainless steel lamp spring ensures positive lamp retention.

**E ... Electronic Ballast**

Electronic ballast provides full light output and rated lamp life. Provides flicker free and noise free operation and starting. One ballast operates all manufacturers' 26W, 32W or 42W triple tube lamps.

**Labels**

cULus listed, C.S.A. certified, standard damp label, IBEW union made.



**C19232**  
**C19242**  
**9250**  
**9210**

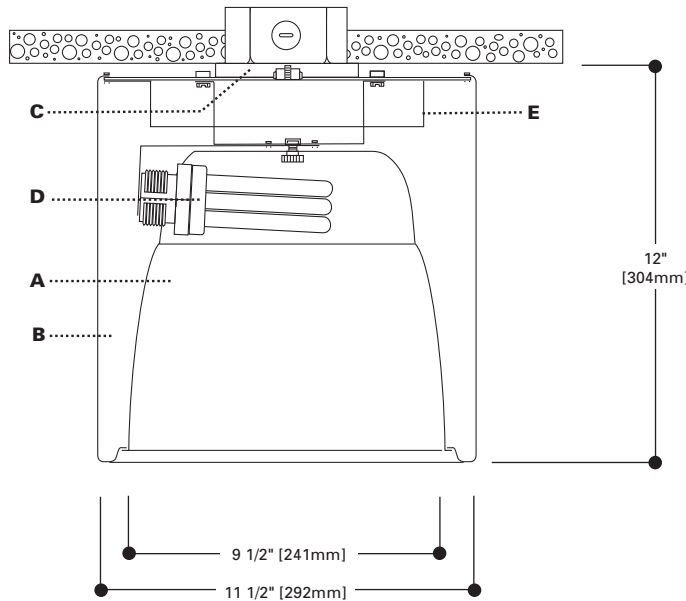
**26W, 32W, 42W TTT**  
**Compact Fluorescent**  
**9 - 1/2" SURFACE CYLINDER**

**Energy Data**

(2) 32W Triple 4-pin  
Ballast: Electronic  
120V Input Watts: 69  
Line Amps: 0.58  
277 Input Watts: 69  
Line Amps: 0.25  
Power Factor: >.99, THD: <10%  
Min. Starting Temp: -10°C (15°F)  
Sound Rating: A

**NOTES:**

Accessories should be ordered separately. For additional options, please consult your Cooper Lighting Representative. Alzak is a registered trademark of Aluminum Company of America.



**ORDERING INFORMATION**

Sample Number: Complete unit consists of housing, ballast and trim.

--	--	--	--	--	--	--	--	--	--

**Housing**

**C19:** 9" Cylinder

**Number of Lamps**

**2:** 2 Lamps

**Wattage**

**32:** 26W or 32W TTT Lamp

**42:** 42W TTT Lamp

**Ballast**

**E:** 120/277V 50/60 Hz Electronic

**3E:** 347V 50/60 Hz Electronic

**1D26:** 26W 120V Dimming, Lutron Compact SE

**2D26:** 26W 277V Dimming, Lutron Compact SE

**1D32:** 32W 120V Dimming, Lutron Compact SE

**2D32:** 32W 277V Dimming, Lutron Compact SE

**EDR26:** DeRated Wattage Label, 26W

**EDR32:** DeRated Wattage Label, 32W

**Housing Finish**

**P:** White

**BZ:** Bronze

**MB:** Matte Black

**Trims**

**9250:** WD Beam Surface Trim

**9210:** Single WW Surface Trim

**Finish**

**LI:** Low Iridescent Clear

**H:** Haze

**WMH:** Warm Haze

**G:** Gold

**WH:** Wheat

**W:** Gloss White

**GP:** Graphite

**GPH:** Graphite Haze

**K:** Cognac

**KH:** Cognac Haze

**Accessories**

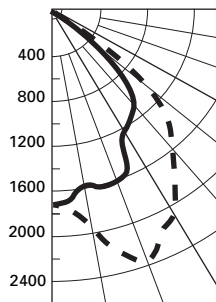
**C836P:** White Pendant Kit for CF Cylinder

**C836BZ:** Bronze Pendant Kit for CF Cylinder

**C836MB:** Black Pendant Kit for CF Cylinder

PHOTOMETRICS

Candlepower Distribution



Test No. H40014  
**C19232-9250LI**  
**Open Reflector**  
 Lamp=(2) 32W PLT  
 Lumens=2400 each  
 Spacing Criteria=  
 0°=1.1, 90°=1.5  
 Efficiency=81.1%

— 0°  
 - - - 90°

Candlepower

Deg.	0°	90°
0	1711	1711
5	1676	1762
15	1572	2207
25	1563	2086
35	1246	1695
45	1027	1296
55	582	739
65	13	15
75	5	5
85	0	0
90	0	0

Average Luminance

Deg.	0°	90°
45	31748	40064
55	22180	28164
65	672	776
75	422	422
85	0	0

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
5'6"	57	8'0"
6'6"	40	9'6"
8'0"	27	12'0"
10'0"	17	14'6"
12'0"	12	17'6"
14'0"	9	20'6"

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial, apply appropriate light loss factors where necessary.

Reflector Multiplier

Haze=.95  
 Straw=.90  
 Wheat=.90

Zonal Lumen Summary

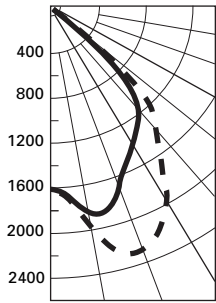
Zone	Lumens	%Lamp	%Luminaire
0-30	1594	33.2	40.9
0-40	2528	52.7	64.9
0-60	3873	80.7	99.5
0-90	3893	81.1	100.0
90-180	0	0.0	0.0
0-180	3893	81.1	100.0

Coefficient of Utilization

rc	80%				70%				50%				30%				10%				0%			
	70	50	30	10	50	30	10	50	10	50	10	50	10	50	10	50	10	50	10	50	10			
RCR																								
0	97	97	97	97	94	94	94	90	90	86	86	83	83	81	81	81	81	81	81	81	81	81	81	
1	91	89	87	85	87	85	83	84	81	91	78	78	76	74	74	74	74	74	74	74	74	74	74	
2	86	82	78	75	80	77	74	78	73	75	71	73	70	68	68	68	68	68	68	68	68	68	68	
3	81	75	71	67	74	70	66	72	65	70	64	68	63	62	62	62	62	62	62	62	62	62	62	
4	76	69	64	60	68	63	60	66	59	65	58	63	58	56	56	56	56	56	56	56	56	56	56	
5	71	63	58	54	63	57	54	61	53	60	53	58	52	51	51	51	51	51	51	51	51	51	51	
6	66	58	52	48	57	52	48	56	48	55	47	53	47	46	46	46	46	46	46	46	46	46	46	
7	61	52	47	43	52	46	42	51	42	50	42	49	42	41	41	41	41	41	41	41	41	41	41	
8	57	48	42	38	47	42	38	46	38	45	38	45	37	36	36	36	36	36	36	36	36	36	36	
9	53	43	38	34	43	37	34	42	34	41	33	41	33	32	32	32	32	32	32	32	32	32	32	
10	49	40	34	30	39	34	30	39	30	38	30	37	30	29	29	29	29	29	29	29	29	29	29	

rc=Ceiling reflectance, rw=Wall reflectance, RCR=Room cavity ratio  
 CU Data Based on 20% Effective Floor Cavity Reflectance.

Candlepower Distribution



Test No. H40013  
**C19232-9210LI**  
**Wall Wash/ Downlight**  
 Lamp=(2) 32W PLT  
 Lumens=2400 each  
 Efficiency=82.0%

— 0°  
 - - - 180°

Candlepower

Deg.	0° Wall	180° Dwnlt
0	1622	1622
5	1637	1702
15	1910	2154
25	1668	2199
35	1467	1693
45	1156	1296
55	617	748
65	359	12
75	193	4
85	48	1
90	0	0

Average Luminance

Deg.	0° Wall	180° Dwnlt
45	36736	40064
55	23514	28507
65	18569	621
75	16300	338
85	12039	251

Single Fixture 2'6" From Wall

DD	Distance From Fixture Along Wall					
	1'	2'	3'	4'	5'	6'
1	38	28	13	5	2	1
2	63	46	22	9	4	2
3	56	46	28	14	6	2
4	36	33	23	14	8	4
5	23	22	18	12	8	5
6	16	15	13	10	7	5
7	11	11	10	8	6	4
8	8	8	7	6	5	3
9	6	6	5	5	4	3
10	4	4	4	4	3	2

2'6" Distance From Wall

DD	Spacing Between Fixtures					
	3'			4'		
1	48	41	48	42	26	42
2	82	71	82	71	45	71
3	86	81	86	68	59	68
4	66	69	66	53	50	53
5	50	53	50	40	41	40
6	38	39	38	30	32	30
7	29	30	29	24	25	24
8	23	23	23	19	19	19
9	17	18	17	15	15	15
10	14	14	14	12	12	12

3' Distance From Wall

DD	Spacing Between Fixtures					
	3'			4'		
1	32	31	32	26	21	26
2	56	55	56	45	38	45
3	73	71	73	57	51	57
4	65	65	65	51	48	51
5	50	54	50	41	41	41
6	40	41	40	32	34	32
7	32	32	32	26	27	26
8	25	25	25	21	21	21
9	20	20	20	17	17	17
10	16	16	15	14	14	14

4' Distance From Wall

DD	Spacing Between Fixtures					
	4'			6'		
1	14	13	14	11	7	11
2	26	25	26	20	14	20
3	34	33	34	27	19	27
4	41	40	41	30	24	30
5	38	38	38	28	35	28
6	32	34	32	23	22	23
7	27	28	27	20	20	20
8	22	23	22	16	17	16
9	19	19	19	14	15	14
10	16	16	16	12	12	12

## DESCRIPTION

A graceful arched housing with elegantly contoured perforated lamp diffuser. Available in (1'x2') or (1'x4') configuration, this luminaire has no visible lamps, fasteners, hardware, or glaring reflectors, just soft, diffused wall lighting. "The Fenestra" Series 112/114 features a totally soft wide distribution wall light. The precisely crafted components provide for a high-tech appearance and a low tolerance fit. These elements combined make the Neo-Ray Fenestra Series 112/114 an appropriate luminaire for application in executive offices, private offices, conference rooms, corridors, open office spaces, VDT workspaces, reception areas and dining spaces.

Catalog #		Type
Project		H
Comments		Date
Prepared by		

## SPECIFICATION FEATURES

### A ... Construction

20-gauge steel housing (1'x2' or 1'x4').

### B ... Shielding

Perforated metal panels backed by a white acrylic diffuser.

### C ... Electrical

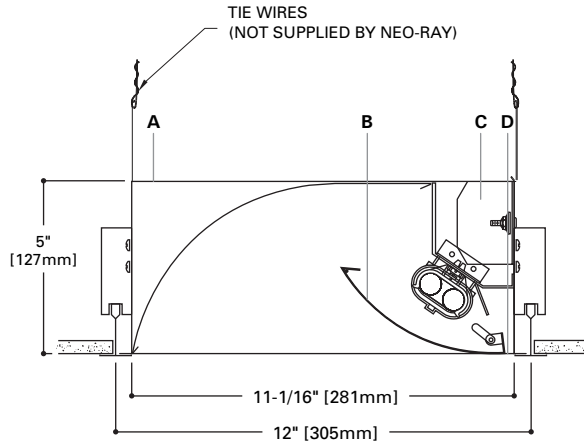
120, 277, 347 or Universal Voltage electronic ballast. Fixtures and electrical components certified to UL and CUL standards.

### D ... Finish

Durable, low gloss, white, powder coated acrylic finish.

### Mounting

Recessed. Specify:  
 (ETG) 15/16" Flat Exposed T-grid,  
 (STG) 9/16" Screw Slot T-grid,  
 (SR) Sheet Rock (Flanged),  
 (FSR) Sheet Rock (Flangeless),  
 (FTG) 9/16" Flat Exposed T-grid.



### STANDARD LUMINAIRE PLAN

	12" x 24" (305mm x 610mm) (1 lamp)		12" x 48" (305mm x 1219mm) (1 lamp)
--	--	--	---

## Fenestra

112

114

1T5

1T5HO

Long Twin Tube

Recessed

Direct-Indirect

Wall Wash

Light Distribution:

Indirect - 0.0%

Direct - 100.0%

## TANNENBAUM



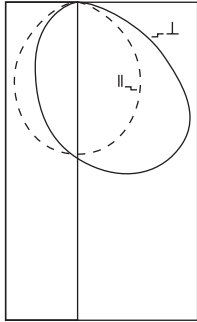
Optional rippled aluminum reflector.

## ORDERING INFORMATION

<b>Series</b> 112: 1' x 2' 114: 1' x 4'	<b>Options</b> <sup>1</sup> C: Chicago Plenum A: Air Return T: Tannenbaum Reflector	<b>Mounting</b> R: Recessed	<b>Number of Lamps</b> 1: 1 Lamp (Not included)  <b>Lamp Type</b> T5 T5HO BX40W BX50W	<b>Ceiling Type</b> ETG: 15/16" Exposed T-Grid STG: Slot T-Grid SR: Sheet Rock (Flanged) FTG: 9/16" Exposed T-Grid FSR: Sheet Rock (Flangeless)	<b>Voltage</b> <sup>2</sup> 1: 120V 2: 277V 3: 347V	<b>Ballast</b> EB: Electronic Ballast DB: Dimming Ballast  <b>Switching Options</b> SI: Single Switching	<b>Emergency</b> EM: Emergency Pack
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Notes: 1 Can be left blank or more than one option may be available, consult factory.  
 2 Not all options available. Please consult your Cooper Lighting Representative for availability.

PHOTOMETRICS



112R

(1) F40/30BX3SPX35  
3150 Lumens

Efficiency 47.2%

Test Report  
#LSI 15655

(Consult factory for I.E.S. data  
not included within this report.)

Coefficients of Utilization

rc	Effective floor cavity reflectance																					
	80%				70%				20%													
	50	30	10	0	50	30	10	0	50	30	10	0										
rw	70	50	30	10	70	50	30	10	50	30	10	0	50	30	10	50	30	10	50	30	10	0
<b>RCR</b>																						
0	56	56	56	56	55	55	55	55	52	52	52	52	50	50	50	48	48	48	47	47	47	
1	52	50	48	47	51	49	47	46	47	46	44	44	45	44	43	44	43	42	41	41	41	
2	48	45	42	39	47	44	41	39	42	40	38	38	41	39	37	39	38	36	35	35	35	
3	44	40	36	33	43	39	36	33	38	35	33	33	36	34	32	35	33	32	31	31	31	
4	41	36	32	29	40	35	32	29	34	31	29	29	33	30	28	32	30	28	27	27	27	
5	38	32	28	25	37	32	28	25	31	27	25	25	30	27	25	29	26	24	23	23	23	
6	35	29	25	22	34	28	25	22	27	24	22	22	27	24	22	26	23	21	20	20	20	
7	32	26	22	19	31	25	22	19	25	21	19	19	24	21	19	23	21	19	18	18	18	
8	30	23	20	17	29	23	19	17	22	19	17	17	22	19	17	21	19	17	16	16	16	
9	27	21	18	15	27	21	17	15	20	17	15	15	20	17	15	20	17	15	14	14	14	
10	26	19	16	13	25	19	16	13	19	15	13	13	18	15	13	18	15	13	12	12	12	

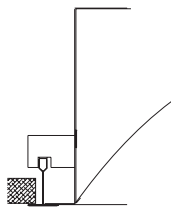
Zonal Lumen Summary

Zone	Lumens	Lamp%	Fixt%
0-30	440	14.00	29.64
0-40	716	22.74	48.16
0-60	1230	39.07	82.73
0-90	1487	47.22	100.00
40-90	771	24.48	51.84
60-90	256	8.16	17.27
90-180	0	.00	.00
0-180	1487	47.22	100.00
Total Luminaire Efficiency= 47.2%			

Candlepower

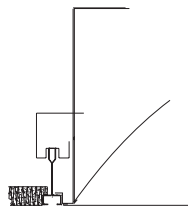
Vertical Angle	Horizontal Angle		
	0	45	90
0	570	570	570
5	562	591	609
10	551	608	639
15	535	614	660
20	512	613	675
25	484	605	683
30	452	590	682
35	415	569	669
40	374	541	645
45	329	504	604
50	281	457	538
55	232	400	452
60	183	325	360
65	139	238	279
70	100	162	211
75	64	99	146
80	32	53	80
85	10	18	25
90	0	0	0

MOUNTING INFORMATION



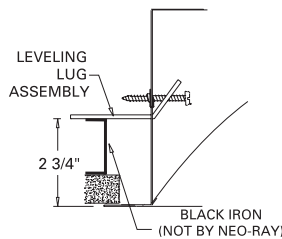
ETG

STANDARD LAY-IN CEILING  
(GRID LAY-IN)



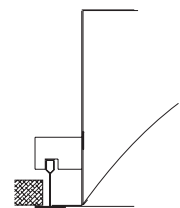
STG

SCREW SLOT CEILING  
(SLOT-T)



SR

SHEET ROCK CEILING  
(FLANGE)



FTG

STANDARD LAY-IN CEILING  
(GRID LAY-IN)

## DESCRIPTION

A seamless continuous line of light and walls softly glowing...that is what every lighting consultant and architect visualizes when designing perimeter wall lighting for their spaces.

### Features

- PentaFlex (TM) reflector system, continuous and seamless up to 40'.
- Smooth softly graduated wall illumination without a hint of lamp sockets shadows.
- Totally shielded lamps from all viewing angles.
- Installation friendly.

Catalog #		Type	H1
Project		Date	
Comments		Prepared by	

## SPECIFICATION FEATURES

### A ... Construction

20-gauge steel housing.

### B ... Shielding

PentaFlex™, continuous white reflector is seamless up to 40'.

### C ... Electrical

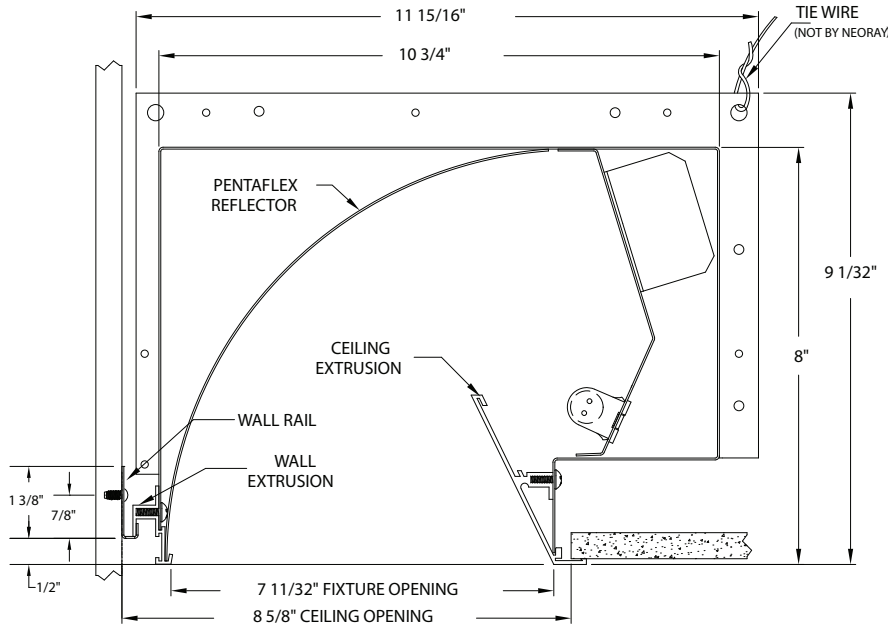
120, 277, 347 or Universal Voltage electronic ballast. Fixtures and electrical components certified to UL and CUL standards.

### D ... Finish

Durable, low gloss, white, powder coated acrylic finish.

### Mounting

Recessed.



Note: Actual wall length must be provided; Do Not round up  
Refer to run length chart on page 3

## PentaFlex™ 79-PF

1 & 2T8  
1 & 2T5  
1 & 2T5HO

**Perimeter**  
Direct Wall Wash

**Light Distribution:**  
Indirect - 0.0%  
Direct - 100.0%

## Ordering Information

Sample Number: 79PF-2T5-300-UEB-SI

<b>79PF</b>								
<b>Series</b> 79PF = 79PF	<b>Number of Lamps</b> 1=1 Lamp 2=2 Lamps	<b>Lamp Type</b> T8=T8 T5=T5 T5HO=T5HO	<b>Length of run along the wall</b> <sup>2</sup> ___ Ft ___ In	<b>Voltage</b> <sup>1</sup> 1=120V 2=277V 3=347V U=Universal	<b>Ballast</b> EB=Electronic Ballast DB=Dimming Ballast	<b>Switching Options</b> SI= Single Switching DU= Dual Switching	<b>Fusing</b> GLR= GLR GMF= GMF	<b>Flanged End Plate Option</b> <sup>3</sup> EP = End Plate
					<b>Emergency</b> EM= Emergency Pack			

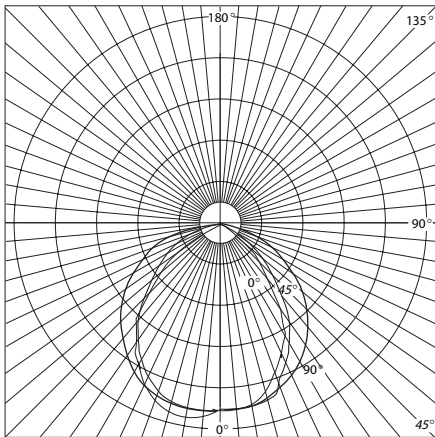
### Notes:

<sup>1</sup> Not all options available. Please consult your Cooper Lighting Representative for availability.

<sup>2</sup> Do not round up

<sup>3</sup> A pair of End Closures per run is provided by default. No flanged end plates are provided. If flanged end plate is required, order EP. See graphics on page 2.

NOTE: Not available as an individual fixture.



**79PF**  
(1) F32T8/735/RS  
2850 Lumens  
Efficiency 34.8%  
Test Report  
#9826.0

**Coefficients of Utilization**

rc	Effective floor cavity reflectance									
	80%				20%					
rw	70	50	30	10	50	30	10	50	30	10
<b>RCR</b>										
1	38	37	35	34	34	33	33	33	32	32
2	35	32	30	28	31	29	27	29	28	27
3	32	29	26	24	27	25	23	26	25	23
4	30	26	23	21	24	22	20	24	22	20
5	27	23	20	18	22	20	18	21	19	18
6	25	21	18	16	20	18	16	19	17	16
7	24	19	16	14	18	16	14	18	16	14
8	22	17	15	13	17	14	13	16	14	13
9	21	16	13	11	16	13	11	15	13	11
10	19	15	12	10	14	12	10	14	12	10

**Candela**

Angle	Along $\parallel$	45°	Across $\perp$
0	401	401	401
5	412	411	406
10	424	422	414
15	424	424	412
20	414	416	401
25	393	402	388
30	338	376	366
35	292	350	353
40	220	296	324
45	156	246	302
50	126	185	271
55	98	129	241
60	55	129	207
65	34	100	174
70	18	70	133
75	4	31	92
80	11	23	49
85	4	8	21
90	0	0	0

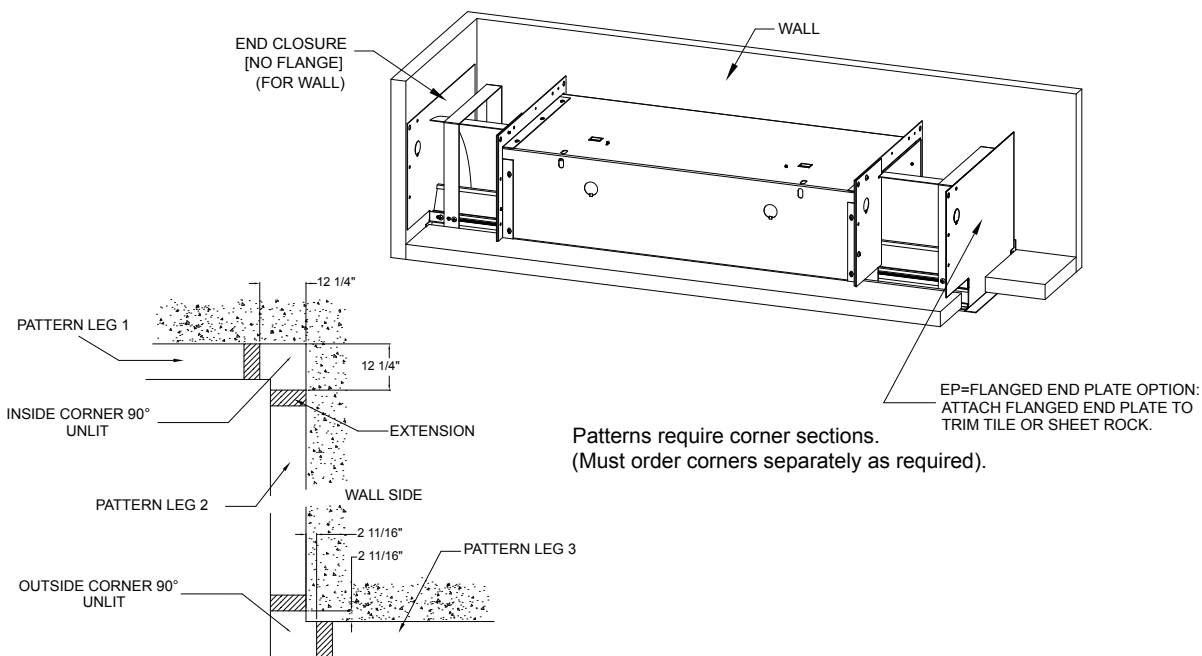
**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	324.87	11.4	32.8
0-40	519.97	18.2	52.4
0-60	844.17	29.6	85.1
0-90	991.42	34.8	100.0
90-180	0	0.0	0.0
0-180	991	34.8	100.0

Total Luminaire Efficiency = 34.8%

**MOUNTING INFORMATION**

NOTE: A pair of End Closures per run are provided by default. No flanged end plates are provided. If flanged end plate is required, order "EP". EP contains a pair of left and right flanged end plates.



Patterns require corner sections.  
(Must order corners separately as required).



Specify wall length in \_\_ Ft \_\_ Inches. Do not round up.  
 Table below depicts resulting run lengths based only on nominal lengths.

H1

NOMINAL LENGTH (FEET)	T5		T8	
	MINIMUM LENGTH (LIGHTED)	MAXIMUM LENGTH	MINIMUM LENGTH (LIGHTED)	MAXIMUM LENGTH
3'	2' 10 1/4"	3' 10 1/4"	3' 0"	4' 0"
4'	3' 10 1/8"	4' 10 1/8"	4' 0"	5' 0"
5'	4' 8 3/4"	5' 8 3/4"	5' 0"	6' 0"
6'	5' 8 1/2"	6' 8 1/2"	6' 0"	7' 0"
7'	6' 8 3/8"	7' 8 3/8"	7' 0"	8' 0"
8'	7' 8 1/8"	8' 8 1/8"	8' 0"	9' 0"
9'	8' 6 3/4"	9' 6 3/4"	9' 0"	10' 0"
10'	9' 6 5/8"	10' 6 5/8"	10' 0"	11' 0"
11'	10' 6 3/8"	11' 6 3/8"	11' 0"	12' 0"
12'	11' 6 1/4"	12' 6 1/4"	12' 0"	13' 0"
13'	12' 4 7/8"	13' 4 7/8"	13' 0"	14' 0"
14'	13' 4 5/8"	14' 4 5/8"	14' 0"	15' 0"
15'	14' 4 1/2"	15' 4 1/2"	15' 0"	16' 0"
16'	15' 4 1/4"	16' 4 1/4"	16' 0"	17' 0"
17'	16' 2 7/8"	17' 2 7/8"	17' 0"	18' 0"
18'	17' 2 3/4"	18' 2 3/4"	18' 0"	19' 0"
19'	18' 2 1/2"	19' 2 1/2"	19' 0"	20' 0"
20'	19' 2 3/8"	20' 2 3/8"	20' 0"	21' 0"
21'	20' 1 1/16"	21' 1 1/16"	21' 0"	22' 0"
22'	21' 0 3/4"	22' 0 3/4"	22' 0"	23' 0"
23'	22' 0 5/8"	23' 0 5/8"	23' 0"	24' 0"
24'	23' 0 3/8"	24' 0 3/8"	24' 0"	25' 0"
25'	24' 10 7/8"	25' 10 7/8"	25' 0"	26' 0"
26'	25' 10 5/8"	26' 10 5/8"	26' 0"	27' 0"
27'	26' 10 1/2"	27' 10 1/2"	27' 0"	28' 0"
28'	27' 9 1/8"	28' 9 1/8"	28' 0"	29' 0"
29'	28' 8 7/8"	29' 8 7/8"	29' 0"	30' 0"
30'	29' 8 3/4"	30' 8 3/4"	30' 0"	31' 0"
31'	30' 8 1/2"	31' 8 1/2"	31' 0"	32' 0"
32'	31' 7 1/8"	32' 7 1/8"	32' 0"	33' 0"
33'	32' 7 1/16"	33' 7 1/16"	33' 0"	34' 0"
34'	33' 6 3/4"	34' 6 3/4"	34' 0"	35' 0"
35'	34' 6 5/8"	35' 6 5/8"	35' 0"	36' 0"
36'	35' 5 1/4"	36' 5 1/4"	36' 0"	37' 0"
37'	36' 5 1/16"	37' 5 1/16"	37' 0"	38' 0"
38'	37' 4 7/8"	38' 4 7/8"	38' 0"	39' 0"
39'	38' 4 5/8"	39' 4 5/8"	39' 0"	40' 0"
40'	39' 3 1/4"	40' 3 1/4"	40' 0"	41' 0"
41'	40' 3 1/8"	41' 3 1/8"	41' 0"	42' 0"
42'	41' 2 7/8"	42' 2 7/8"	42' 0"	43' 0"
43'	42' 2 3/4"	43' 2 3/4"	43' 0"	44' 0"
44'	43' 1 3/8"	44' 1 3/8"	44' 0"	45' 0"
45'	44' 1 1/8"	45' 1 1/8"	45' 0"	46' 0"
46'	45' 1 1/16"	46' 1 1/16"	46' 0"	47' 0"
47'	46' 0 3/4"	47' 0 3/4"	47' 0"	48' 0"
48'	47' 11 1/4"	48' 11 1/4"	48' 0"	49' 0"
49'	48' 11 1/16"	49' 11 1/16"	49' 0"	50' 0"
50'	49' 10 7/8"	50' 10 7/8"	50' 0"	51' 0"
51'	50' 9 1/2"	51' 9 1/2"	51' 0"	52' 0"

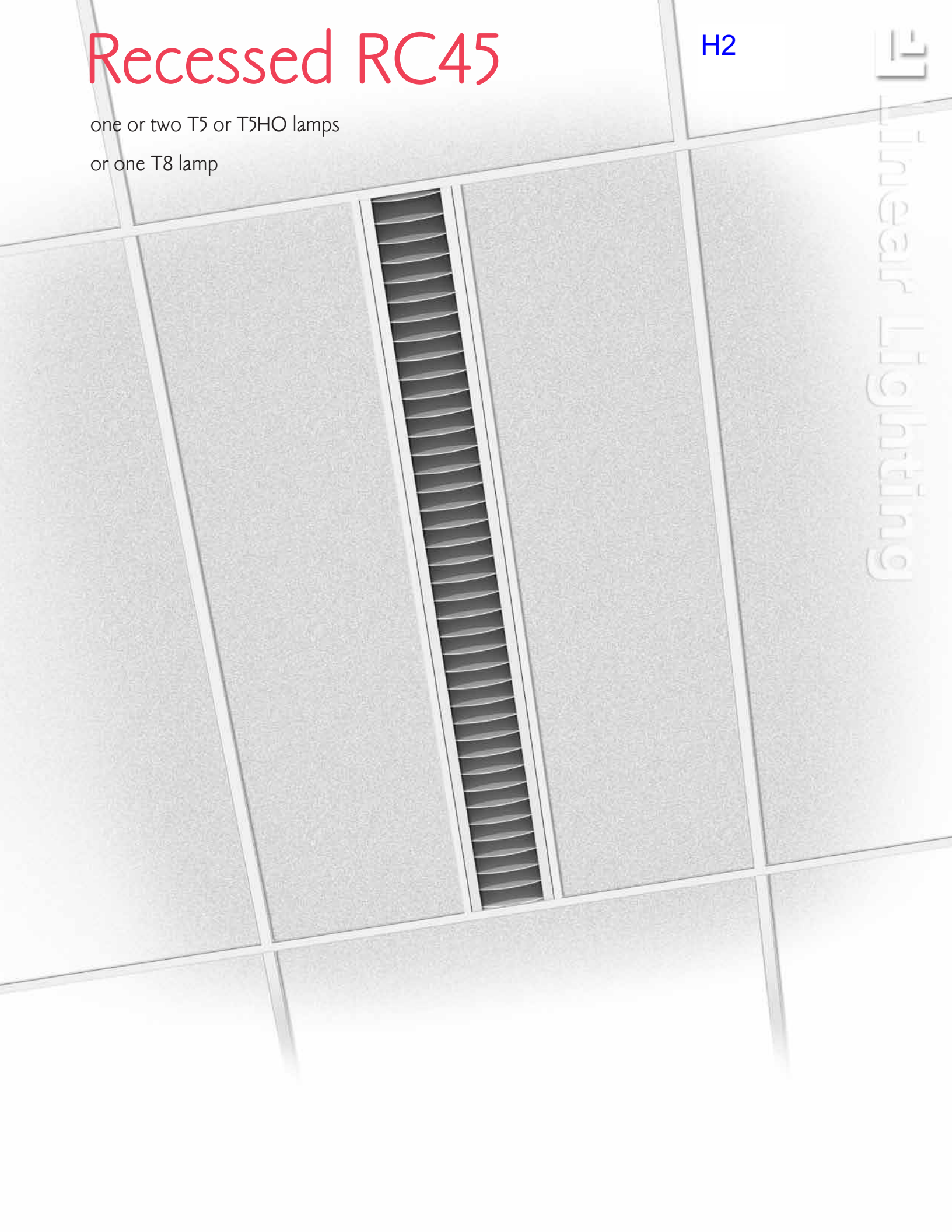
NOMINAL LENGTH (FEET)	T5		T8	
	MINIMUM LENGTH (LIGHTED)	MAXIMUM LENGTH	MINIMUM LENGTH (LIGHTED)	MAXIMUM LENGTH
52'	51' 9 1/4"	52' 9 1/4"	52' 0"	53' 0"
53'	52' 9 1/8"	53' 9 1/8"	53' 0"	54' 0"
54'	53' 8 7/8"	54' 8 7/8"	54' 0"	55' 0"
55'	54' 7 1/2"	55' 7 1/2"	55' 0"	56' 0"
56'	55' 7 3/8"	56' 7 3/8"	56' 0"	57' 0"
57'	56' 7 1/8"	57' 7 1/8"	57' 0"	58' 0"
58'	57' 7 1/16"	58' 7 1/16"	58' 0"	59' 0"
59'	58' 5 5/8"	59' 5 5/8"	59' 0"	60' 0"
60'	59' 5 3/8"	60' 5 3/8"	60' 0"	61' 0"
61'	60' 5 1/4"	61' 5 1/4"	61' 0"	62' 0"
62'	61' 5 1/16"	62' 5 1/16"	62' 0"	63' 0"
63'	62' 3 5/8"	63' 3 5/8"	63' 0"	64' 0"
64'	63' 3 1/2"	64' 3 1/2"	64' 0"	65' 0"
65'	64' 3 1/4"	65' 3 1/4"	65' 0"	66' 0"
66'	65' 3 1/8"	66' 3 1/8"	66' 0"	67' 0"
67'	66' 1 3/4"	67' 1 3/4"	67' 0"	68' 0"
68'	67' 1 1/2"	68' 1 1/2"	68' 0"	69' 0"
69'	68' 1 3/8"	69' 1 3/8"	69' 0"	70' 0"
70'	69' 1 1/8"	70' 1 1/8"	70' 0"	71' 0"
71'	70' 11 5/8"	71' 11 5/8"	71' 0"	72' 0"
72'	71' 11 3/8"	72' 11 3/8"	72' 0"	73' 0"
73'	72' 11 1/4"	73' 11 1/4"	73' 0"	74' 0"
74'	73' 9 7/8"	74' 9 7/8"	74' 0"	75' 0"
75'	74' 9 5/8"	75' 9 5/8"	75' 0"	76' 0"
76'	75' 9 1/2"	76' 9 1/2"	76' 0"	77' 0"
77'	76' 9 1/4"	77' 9 1/4"	77' 0"	78' 0"
78'	77' 7 7/8"	78' 7 7/8"	78' 0"	79' 0"
79'	78' 7 3/4"	79' 7 3/4"	79' 0"	80' 0"
80'	79' 7 1/2"	80' 7 1/2"	80' 0"	81' 0"
81'	80' 7 3/8"	81' 7 3/8"	81' 0"	82' 0"
82'	81' 6 1/16"	82' 6 1/16"	82' 0"	83' 0"
83'	82' 5 3/4"	83' 5 3/4"	83' 0"	84' 0"
84'	83' 5 5/8"	84' 5 5/8"	84' 0"	85' 0"
85'	84' 5 3/8"	85' 5 3/8"	85' 0"	86' 0"
86'	85' 4 1/16"	86' 4 1/16"	86' 0"	87' 0"
87'	86' 3 7/8"	87' 3 7/8"	87' 0"	88' 0"
88'	87' 3 5/8"	88' 3 5/8"	88' 0"	89' 0"
89'	88' 3 1/2"	89' 3 1/2"	89' 0"	90' 0"
90'	89' 2 1/8"	90' 2 1/8"	90' 0"	91' 0"
91'	90' 1 7/8"	91' 1 7/8"	91' 0"	92' 0"
92'	91' 1 3/4"	92' 1 3/4"	92' 0"	93' 0"
93'	92' 1 1/2"	93' 1 1/2"	93' 0"	94' 0"
94'	94' 0 1/16"	95' 0 1/16"	94' 0"	95' 0"
95'	94' 11 3/4"	95' 11 3/4"	95' 0"	96' 0"
96'	95' 11 5/8"	96' 11 5/8"	96' 0"	97' 0"
97'	96' 10 1/4"	97' 10 1/4"	97' 0"	98' 0"
98'	97' 10 1/16"	98' 10 1/16"	98' 0"	99' 0"
99'	98' 9 7/8"	99' 9 7/8"	99' 0"	100' 0"
100'	99' 9 5/8"	100' 9 5/8"	100' 0"	101' 0"

# Recessed RC45

H2

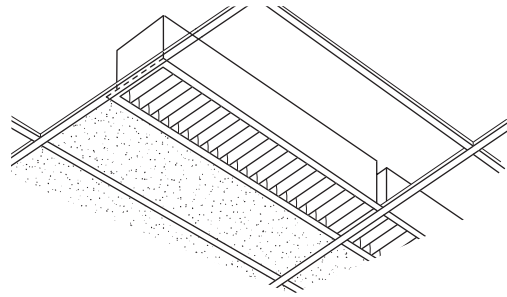
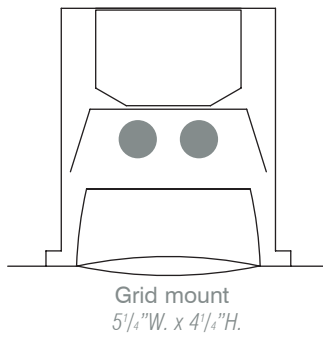
one or two T5 or T5HO lamps  
or one T8 lamp

Linear Lighting

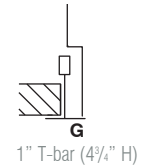
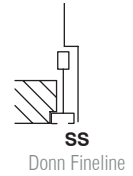


# Recessed RC45

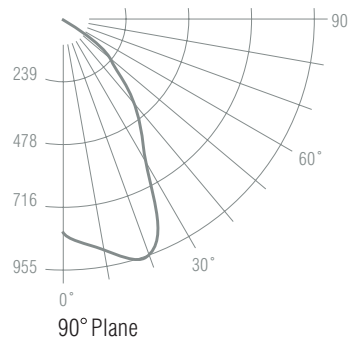
# H2



For design use only. Not for construction. See [www.linearlgt.com](http://www.linearlgt.com) for engineering drawings specific to job.



- Pre-painted white steel housing
- 1 or 2 T5 or T5HO or 1 T8 lamps
- 3" aperture
- Factory pre-wired
- UL/CUL labels
- Fixture weight: 3.3 lbs. approx.



RC45-D-1-ET5-PBL

Efficiency: 55%

Max. candlepower at 20°: 955

See [www.linearlgt.com](http://www.linearlgt.com) for complete photometrics.

Catalog No.	Dir.	Lamps	Ballast	Voltage	Shielding	Mounting	Color	Add'l options	Row length	
<b>RC45</b>	<b>D-</b>	-	-	-	-	-	<b>BW</b>	-	-	
Fixture	Lamps & Electrical Options				Mechanical & Aesthetic Options			Add'l	Feet	
Direction	<b>Direct</b>				Shielding	<b>AL</b> K19 Acrylic Lens <b>DIF</b> Acrylic Diffuser/Louwer <b>MBP</b> Magnabeam Perforated Louwer <b>PBL</b> Parabolic Louwer <b>SBL</b> Sandblasted lens <b>PVL</b> Parabolic Concave Louwer <b>PXL</b> Parabolic Convex Louwer <b>PV_LIC</b> Concave Parblc w/Clear Convex Insert <b>PV_LIG</b> Concave Parblc w/ Green Convex Insert <i>See tab for louwer illustrations</i>	Mounting	<b>G</b> 1" T-bar <b>NFG</b> 3/8" T-bar <b>SS</b> Donn Fineline <b>F</b> Flanged	Color	<b>BW</b> Baked White
Lamps	<b>1</b> or <b>1_AR</b> T5/ T5HO <b>1</b> or <b>1_AR</b> T8 <b>2</b> T5/ T5HO				Color	<b>NO</b> No Option <b>CB</b> Chckrboard Circuit "A" or "B" <b>CP</b> Chicago Plenum Code <b>EC</b> Emergency Circuits <b>ED</b> Electronic Dimming* <b>EM</b> Emergency Ballast** <b>FU</b> Fusing <b>ISB10</b> Instant Start Ballast <10%†† <b>LO</b> Louwer Overlay <b>LS</b> LutronEcoSys Sensor Feed <b>LW</b> White Louwer††† <b>NL</b> Night Light <b>PBIS</b> Premium Bist. Instant Start <b>PBPS</b> Prem Ballast Prog Start <b>PSB10</b> Program Start Ballast <10%†† <b>RFI</b> Radio Frq Int Suprsr <b>SC</b> Separate Circuits <b>SF</b> Special Feature <i>Please define</i>	Row length	Fixture lengths Grid <b>2' 3', 4', 5', 6', 8'</b> Flanged <b>2', 3', 4', 5', 6', 8'</b>		
Ballast	<b>ET5</b> Electronic T5 <b>ET5HO</b> High Output T5 <b>ET8</b> Electronic T8				Color	<b>BW</b> Baked White	Color	<b>BW</b> Baked White	Color	<b>BW</b> Baked White
Voltage	<b>120, 277, 347</b>				Color	<b>BW</b> Baked White	Color	<b>BW</b> Baked White	Color	<b>BW</b> Baked White

\* Dimming ballasts may not be available for all T5/T5HO lamp lengths. Consult factory.

\*\* EM packs may not be available for all T5/T5HO lamp lengths. Consult factory.

† Available with 1-T5 configuration only.

†† ISB10 and PSB10 available with T8 only.

††† Not available for PVL louwers.

**Linear Lighting Corp.**

31-30 Hunters Point Ave., Long Island City, NY 11101 ©9/10

718-361-7552 Fax 718-937-2747 Web: [www.linearlgt.com](http://www.linearlgt.com)

See [www.linearlgt.com](http://www.linearlgt.com) for IES files and additional information.



# Lightline® Direct

## Suspended / Surface Wall Wash T5 / T5HO

Type: **H3**

Project:

### SPECIFICATIONS

Rectangular 3 5/8" x 4 1/16"

LLMW

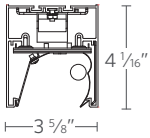
### CATALOG NUMBER

FT

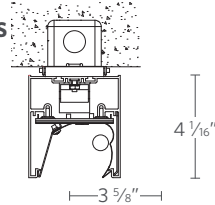
Examples: LLMW 1 28T5 40FT R8 GEB10 SCT LP835 C100 F1/18 - LLMW S 1 28T5 40FT R8 GEB10 1SE EC SCT LP835 C041

### AVAILABLE FIXTURES

□ LLMW



□ LLMW S



### SPECIFICATIONS

#### Construction

Extruded aluminum housing forms a 3 5/8" x 4 1/16" rectangular channel. Die-cast aluminum end caps mechanically attach with no exposed fasteners.

#### Reflectors

Specular asymmetric reflector system with black perforated metal diffuser.

#### Finish

Satin anodized or white polyester powder paint. Consult factory for special finish requirements.

#### Electrical

Specify 120 volt, 277 volt or 347 volt. Pre-wired with prescribed circuits as specified. C-UL listed and labeled. For special circuiting, consult factory.

#### Fixture Length

4', 8' and 12' lengths in a single section. For total fixture length, add 7/8" for each end cap. Using internal joiners, 4', 8' and 12' sections can be joined to form longer rows.

### ORDERING LOGIC

FT								
Fixture	Mounting Type	# of Lamps in Cross Section	Lamp Type	Nominal Row Length <sup>1</sup>	Maximum Row Section Length	Voltage	Ballast Type	# of Emergency Modules
LLMW	(Blank) Suspended S Surface	1	54T5HO 28T5		R4 4' Section R8 8' Section R12 12' Section	120 277 347	GEB10 <10% THD ELECTRONIC  Dimming Ballasts Available: ADEZ <sup>2,3</sup> Advance Mark 10 ECO10 <sup>2</sup> Lutron ECO-10 ADZT <sup>2</sup> Mark 7 (0-10 Volt) OSDIM <sup>2,3</sup> Osram 0-10V dim SS <sup>2</sup> SIMPLY5™  Reference <a href="#">Ballast Chart</a> on website or consult factory for other options.	(Blank) None 1SE 2SE XSE
Emergency Type <sup>4</sup>	Switching	Lamp Color	Housing & Wing Finish	Mounting Type	Overall Suspension	Options		
(Blank) None EL <sup>2</sup> Emergency Battery Pack EC Emergency Circuit EN <sup>2</sup> Emergency Battery Pack w/ Night Light	SCT Single Circuit	L/LP No Lamp LP830 3000K 80+ CRI LP835 3500K 80+ CRI LP841 4100K 80+ CRI  T5 Only LP830P 3000K 80+ CRI Premier LP835P 3500K 80+ CRI Premier LP841P 4100K 80+ CRI Premier  Reference <a href="#">Lamp Chart</a> on website or consult factory for other options.	C100 Satin Anodized Finish C041 White White (low gloss) C099 Custom Finish	(Blank) "S" Surface Mount F1 T-Bar Ceiling (Universal Mounting Bracket) F1A T-Bar Ceiling (UMB with Integrated J-Box) F2 Hard ceiling horizontal J-box F3 Stem Mount F4A IDS Clip 1 5/16" Tee F4B IDS Clip 9/16" Tee F4C IDS Clip Screw Slot	(Blank) "S" Surface Mount 12 12" overall suspension 15 15" overall suspension 18 18" overall suspension 21 21" overall suspension 24 24" overall suspension XX XX" overall suspension	ACG Adjustable Cable Grippers CP Chicago Plenum DL Damp Location Label ELH EM Through Wire Harness ELS EM Through Wire Harness with Single Feed ELS2 Normal feed w/ EM separate neutral GLR Fast Blow Fuse GMF Slow Blow Fuse MCS Matching feed canopy at support OJB Offset Junction Box NYC New York City Code		
<b>Notes:</b> 1 Must be in 4' increments. 2 Not available in 347 volt. 3 Not available with 28T5 Lamp Type. 4 Emergency type is installed in the last 4' of fixture sections. Separate feed unless ELS/ELH is specified.								

# Lightline® Direct

Suspended / Surface, Wall Wash T5 / T5HO

Type: **H3**

Project:

**PHOTOMETRICS**

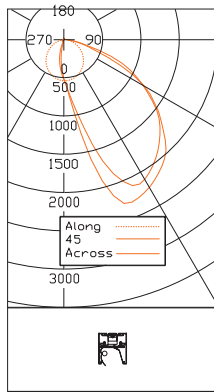
Rectangular 3 5/8" x 4 1/16"

LLMW

**1-LAMP T5HO**

FAR-FIELD PHOTOMETRY  
 REPORT NUMBER: 8021 DATE: 5-6-2009

CATALOG NUMBER: LLMW-1-54T5HO-SSB  
 LUMINAIRE: 3 1/2" W x 3 3/4" H RECESSED WALL WASH WITH ASYMMETRIC-THROW  
 SPECULAR REFLECTOR AND PERF BLACK TRIM  
 LAMP(S): FP54/835/HO/ECO RATED @ 5000 LUMENS  
 BALLAST: QTP 2X54T5HO/UNV PSN  
 MOUNTING:  
 LUMEN TO CANDELA RATIO USED = 9.15  
 TOTAL INPUT WATTS = 60.5 AT 120.0 VOLTS  
 THE 0 DEGREE PLANE IS PERPENDICULAR TO THE LAMPS.



CANDELA DISTRIBUTION		FLUX		
0.0	45.0	90.0	135.0	180.0
0	538	538	538	538
5	746	703	540	437
15	1915	1426	518	237
25	2286	2108	477	61
35	2139	2014	423	30
45	1864	1766	351	26
55	1431	1403	270	23
65	814	949	183	16
75	255	298	90	4
85	6	15	14	0
90	0	0	0	0

ZONAL LUMEN SUMMARY		%LAMP	%FIXT
ZONE	LUMENS		
0-30	721	14.4	23.1
0-40	1302	26.0	41.8
0-60	2514	50.3	80.7
0-90	3114	62.3	100.0
90-180	0	0.0	0.0
0-180	3114	62.3	100.0

TOTAL LUMINAIRE EFFICIENCY = 62.3 %  
 CIE TYPE - DIRECT

LUMINANCE DATA IN FOOTLAMBERTS

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	9935	9409	1873
55	9409	9226	1777
65	7265	8466	1630
75	3708	4342	1306
85	271	638	599



APPROVED BY:

BARE LAMP LUMEN VALUE IS RATED AT LAMP OPERATING TEMPERATURE INSIDE THE LUMINAIRE.  
 FOR DETAIL EXPLANATIONS, PLEASE SEE PEERLESS PUBLICATION # A62

\*Use a 0.58 multiplier for T5.

## DESCRIPTION

Series 14 offers fixtures for wall mounted applications. Used individually or in continuous illuminated runs and patterns, each fixture is uniquely suited to achieve many functional and aesthetic spatial effects.

### Features:

- Separate direct and indirect lamp chambers for 3 distinct distributions.
- The light is continuous and broken.
- Individual units and runs are provided to the nearest foot.
- Patterns are created by butting standard length fixtures.
- The trim is rigid "U" shaped, double formed with a 3/8" regress soft-lit edge; housing may be ordered custom finished.

## SPECIFICATION FEATURES

### A ... Construction

20-gauge steel housing. Nominal 3', 4', 6' or 8' illuminated sections.

### B ... Shielding

White bold baffle louver. White acrylic diffuser. Prismatic acrylic lens. Parabolic baffle shielding.

### C ... Electrical

120, 277, 347 or Universal Voltage electronic ballast. Fixtures and electrical components certified to UL and CUL standards.

### D ... Finish

Durable, low gloss, white, powder coated acrylic finish.

### End Caps

20-gauge steel construction.

### Mounting

Wall mounted.

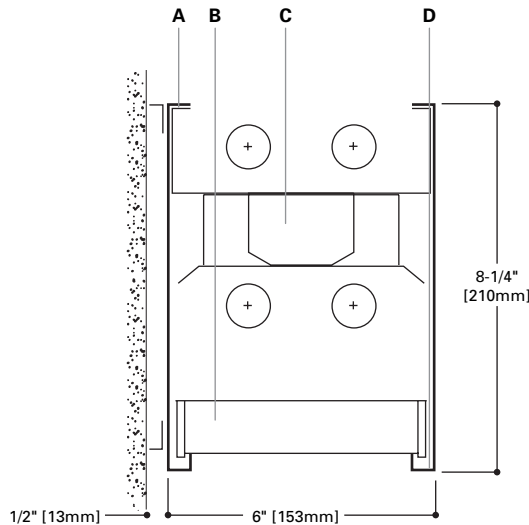


## Geo 14-DIW

2, 3 & 4T8  
2, 3 & 4T5  
2, 3 & 4T5HO

**Wall**  
Direct-Indirect

**Light Distribution:**  
Indirect - 49.0%  
Direct - 51.0%



## ORDERING INFORMATION

# H4

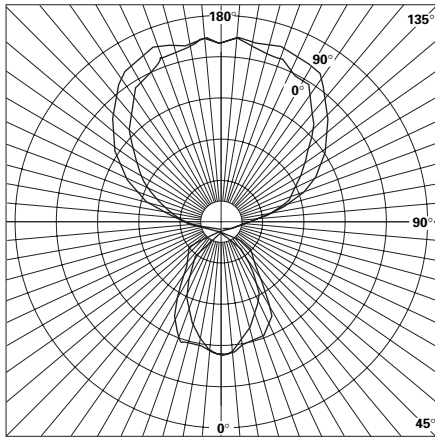
Sample Number: 14DIW-21T8-40-1EB-SI-S58

<b>Series</b> 14: Geo	<b>Light Output</b> DI: Direct/Indirect	<b>Number of Lamps Up</b> 1: 1 Lamp 2: 2 Lamps	<b>Lamp Type</b> T8: T8 T5: T5 T5HO: T5HO	<b>Voltage</b> <sup>1</sup> 1: 120V 2: 277V 3: 347V	<b>Ballast</b> EB: Electronic Ballast DB: Dimming Ballast	<b>Emergency</b> EM: Emergency Pack	<b>Fusing</b> GLR: GLR GMF: GMF
	<b>Mounting</b> W: Wall	<b>Number of Lamps Down</b> 1: 1 Lamp 2: 2 Lamps	<b>Run Length</b> Overall Nominal Run Length ___ ft.		<b>Switching Options</b> SI: Single Switching DU: Double Switching		<b>Shielding Options</b> S22: White Acrylic Diffuser S58: KSH-12 Acrylic Lens S72: Bold Baffle S79: Parabolic Baffle

Notes: 1 Not all options available. Please consult your Cooper Lighting Representative for availability.



PHOTOMETRICS



**14DIW**  
 (3) F40T12/RS/WW  
 (2 lamp up, 1 lamp down)  
 3200 Lumens  
 Efficiency 58.0%  
 Test Report  
 #2968.0

**Coefficients of Utilization**

rc	Effective floor cavity reflectance									
	80%			50%			20%			
	70	50	30	10	50	30	10	50	30	10
<b>Rv</b>	<b>10</b>	<b>20</b>	<b>30</b>	<b>40</b>	<b>50</b>	<b>60</b>	<b>70</b>	<b>80</b>	<b>90</b>	<b>100</b>
<b>RCR</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
	63	60	58	56	42	41	39	31	30	29
	58	53	49	46	37	35	33	28	26	25
	53	47	42	39	33	31	28	25	23	22
	49	42	37	33	30	27	25	22	20	19
	45	37	32	29	27	24	21	19	16	18
	41	34	29	25	24	21	19	18	16	15
	38	31	26	22	22	19	17	17	15	13
	35	28	23	20	20	17	15	15	13	12
	33	25	21	17	18	15	13	14	12	10
	31	23	19	16	17	14	12	13	11	09

**Candela**

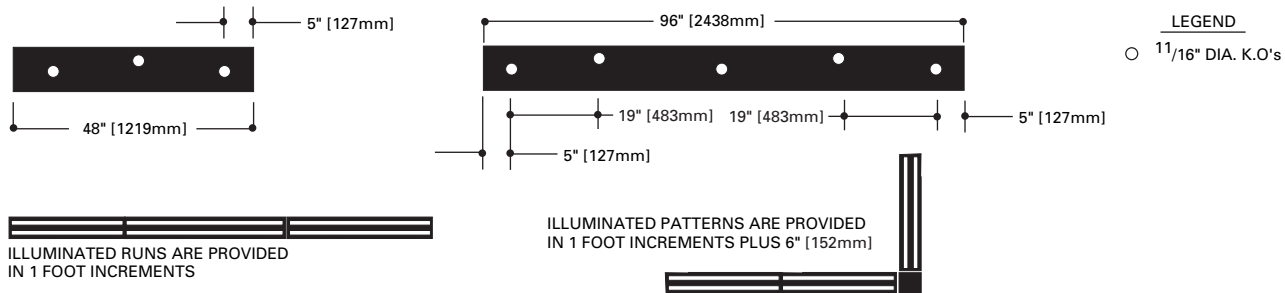
Angle	Along II	45°	Across ⊥
0	983	983	983
5	1008	1010	1004
15	961	532	561
25	556	756	674
35	617	552	467
45	585	326	254
55	331	200	180
65	203	124	112
75	74	58	50
85	17	17	12
90	0	0	0
95	54	54	54
105	307	620	198
115	677	669	459
125	1004	984	764
135	1218	1153	981
145	1445	1379	1237
155	1555	1504	1408
165	1597	1583	1523
175	1591	1588	1583
180	1559	1559	1559

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	348	0.0	0.0
0-40	1020	0.0	0.0
0-60	1444	3.0	4.0
0-90	1646	2.0	0.2
0-120	2682	27.9	41.1
0-180	65290	58.0	100.0

Total Luminaire Efficiency = 58.0%

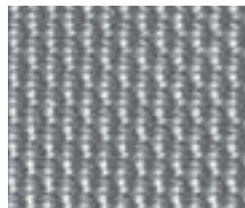
**MOUNTING INFORMATION**



**SHIELDING INFORMATION**



**S22 Acrylic Diffuser**  
 3/16" thick, matte white finish, rabbeted joints, no light leaks.



**S58 Acrylic Lens**  
 1/8" thick, clear acrylic prismatic lens.



**S72 Bold Baffle**  
 1" high x 1.2" o.c., 3/16" thick aluminum baffle, continuous and unbroken, no visible joints.



**S79 Parabolic Baffle**  
 1-1/4" high blades. 2.4" o.c., semi-specular lo-brightness Pearlescent Aluminum baffle. Continuous and unbroken, no visible joints.

J  
TDX SERIES  
Starliter Dome

Architectural Grade Compact Fluorescent High Bay



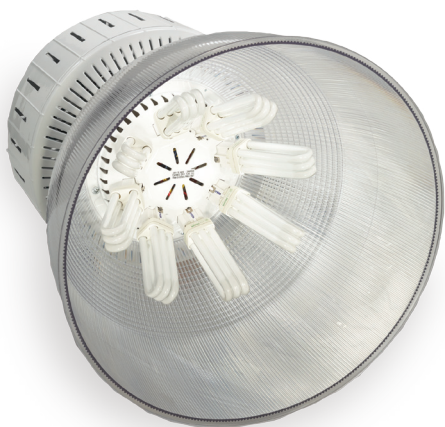
#### Industry First

You will hear people in the industry say "you can't run 8 – 70's in a fixture" and they are right, they can't. They will say, "it's too hot". And for them this is true. But for Sportlite's new "Air Flow" design, our new TDX High Bay with 8 – 70 watt lamps operates so cool, it can be used in 40°C environments. At Sportlite we don't say, "it can't be done" because with the right design it can. That's why, at Sportlite, our motto has always been "Putting Technology In a New Lite".

#### Philips Sportlite Exclusive

- The Only Manufacturer Able To Give You 8 – 70W Lamps With 41,600 Lumens!
- Approved for 40°C Environments using 8 – 70 Watt Lamps
- Cool Running Ballast – Less than 65°C with 8 – 70W Lamps (Independent Testing @ 25°C)

- For Use With The Following Lamps: 70W, 57W, 42W, 32W, 26W
- Complete Ballast Chamber Access While Hanging For Easy Maintenance
- Available with Clear Dome
- Internal Emergency Available with Lamps Up To 42 Watt
- External Emergency Available with Lamps Up To 70 Watt
- Plug-In Ballast Connectors
- 20,000 Hour Lamp Life
- 3/4" Pendant Mount or Hook, Cord and Plug
- 2, 3, or 4 Level Switching Available
- Dimming Ballast available for some lamp wattages
- Standard Color – White
- Custom RAL Colors Available
- 5-Year Warranty





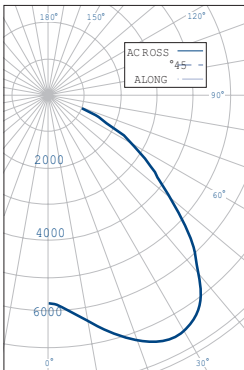
# TDX SERIES: Starlitter Dome

Architectural Grade Compact Fluorescent High Bay

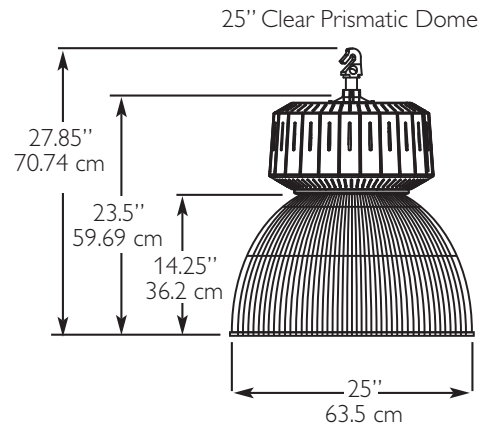
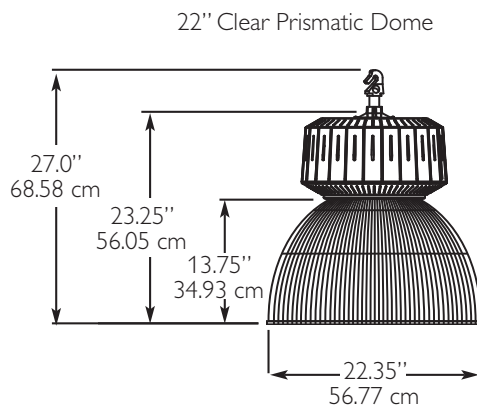
## Technical Data

Input Watts:	336 Watts +/- 3% with 42w Lamps				
Luminous Efficacy:	$\frac{42w}{88.6 \text{ lm/w @ 277V}}$				
Initial Lumens per Lamp:	$\frac{26w}{1,800}$	$\frac{32w}{2,400}$	$\frac{42w}{3,200}$	$\frac{57w}{4,300}$	$\frac{70w}{5,200}$
Total Initial Lumens:	25,600 W/(8) 42 Watt Lamps				
Lumen Maintenance:	85%				
Efficiency:	81.3% of rated lumens				
Color Temperature:	3,000k, 3,500k, 4,100k				
Color Rendering Index:	82 - 84				
Lamp Life:	20,000 hours				
Base:	GX24q-4 + 2G8				
Electronic Ballast:	.98BF, PF=99, THD<2%				
Weight:	Approx. 30lbs depending on Accessories used Suitable for 40°C Ambient				

## Photometrics



## Dimensions



# TDX SERIES: Starlitter Dome

## Step 1: Power-Pack

Ordering Example: TDX6 | T26 | U | 1S | F | HCMPL | 1 | MX | B74S | BL

Series	Wattage	Voltage	Switching <sup>1</sup>	Fuse	Mounting <sup>2</sup>	Dimming Ballast Qty.	Dimming Ballast <sup>3,4,5</sup>	Emergency Ballast <sup>6,7</sup>	Color Options
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Series	Wattage	Voltage	Switching <sup>1</sup>	Mounting <sup>2</sup>
<input type="checkbox"/> TDX8	<input type="checkbox"/> T26 26 Watt	<input type="checkbox"/> 1 120V	<input type="checkbox"/> 1S 1 Switch Leg	<input type="checkbox"/> 3PEN Pendant by Others
<input type="checkbox"/> TDX6	<input type="checkbox"/> T32 32 Watt	<input type="checkbox"/> 2 277V	<input type="checkbox"/> 2S 2 Switch Legs	<input type="checkbox"/> C Single Circuit Cord 6'
<input type="checkbox"/> TDX4	<input type="checkbox"/> T42 42 Watt	<input type="checkbox"/> U Universal	<input type="checkbox"/> 3S 3 Switch Legs	<input type="checkbox"/> CM Multi-Circuit Cord 6'
	<input type="checkbox"/> T57 57 Watt		<input type="checkbox"/> 4S 4 Switch Legs	<input type="checkbox"/> H Male Hook
	<input type="checkbox"/> T70 70 Watt		<b>Fuse</b>	<input type="checkbox"/> HC Male Hook & Single Circuit Cord 6'
			<input type="checkbox"/> F Inline Fuse (One per Switch Leg)	<input type="checkbox"/> HCMPL Male Hook, Multi-Circuit Cord 6' & Locking Plug
				<input type="checkbox"/> HCM Male Hook & Multi-Circuit Cord 6'
				<input type="checkbox"/> HCP Male Hook, Single Circuit Cord 6' & Straight Plug
				<input type="checkbox"/> HCMP Male Hook, Multi-Circuit Cord 6' & Straight Plug
				<input type="checkbox"/> HCPL Male Hook, Single Circuit Cord 6' & Locking Plug

Note:  
Safety Cable provided standard with Power Pack

### Dimming Ballast Quantity

- 1 1 Dimming Ballast
- 2 2 Dimming Ballasts
- 3 3 Dimming Ballasts
- 4 4 Dimming Ballasts
- 5 5 Dimming Ballasts

### Dimming Ballast Options<sup>3,4,5,8,9</sup>

- M7 Advance, Mark VII, 32/42w-Two Lamps, 57/70w-One Lamp
- MX Advance, Mark X, 32/42w-Two Lamp, 57/70w-One Lamp
- HL Lutron Hi-Lume, 26/32w – One lamp
- EC Lutron Ecosystem, 32/42w – Two lamps
- TU Lutron Tu-wire, 26/32w – Two lamps

### Emergency Ballast Options<sup>6,7</sup>

- I42 IOTA I-42B, One Lamp, 32w-650 lm, 42w-750 lm - IM
- 142S<sup>8</sup> IOTA ISD-420A, One Lamp, 32W-1050 lm, 42w-1300 lm, 57w-1160 lm, 70w-1200 lm, Self-Diagnostic - EX
- I42A IOTA I-420A, One Lamp, 32w -1050 lm, 42w-1300 lm, 57w-1160 lm, 70w-1200 lm - EX
- B74S Bodine B74CST, 42w-1000 lm, 32w-750 lm - EX
- B30 Bodine B30, Two Lamp, 42w-3500 lm, One Lamp, 42w-3200 lm - EX
- GTD Bodine, Generator Transfer Device - IM
- B75C Bodine B75C, One Lamp, 32w-600 lm, 42w-800 lm, 57w-1150 lm, 70w-1300 lm - EX
- I160 IOTA I-160, Two Lamp 42w- 3000 lm, One Lamp 57w-2700 lm, One Lamp 70w-2800 lm - EX
- B94C Bodine B94C, 750 Lumens, 42w-One Lamp - IM

### Color Options\*

- BL Blue
- BK Black
- GR Green
- RD Red
- CC Custom Color

Notes:  
Power-Pak standard color shall be white.

## Step 2

Ordering Example: 25EXCP | 22DLCPV | 22RING | 22XWGC | T2627K

Step 2: Field Installed Options and Accessories	Dome	Lens	Ring	Field Installed Accessories	Lamp Accessories Wattage - Lamp
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/> - <input type="text"/>

Dome	Lens	Ring	Field Installed Accessories
<input type="checkbox"/> 22EXCP 22" Clear Prismatic Poly	<input type="checkbox"/> 22DLCPV 22" Conical Poly Prismatic – Vented	<input type="checkbox"/> 22RING 22" Ring	<input type="checkbox"/> 22WG 22" Wire Guard
<input type="checkbox"/> 25EXCP 25" Clear Prismatic Poly	<input type="checkbox"/> 22DL3PV 22" - 3" Drop Poly Prismatic – Vented <sup>8</sup>	<input type="checkbox"/> 25RING 25" Ring	<input type="checkbox"/> 25WG 25" Wire Guard
	<input type="checkbox"/> 22FLCPV 22" Flat Poly Clear – Vented		<input type="checkbox"/> 22XWGC Wire Guard (For Use with Conical Lens)
	<input type="checkbox"/> 22FLPPV 22" Flat Poly Prismatic - Vented		<input type="checkbox"/> 22FWGC Full Wireguard (Covers Entire Reflector)
	<input type="checkbox"/> 25FLCPV 25" Flat Poly Clear – Vented		<input type="checkbox"/> 22WGC 22" Wire Guard, Chrome
			<input type="checkbox"/> 25WGC 25" Wire Guard, Chrome
			<input type="checkbox"/> 22XWGC 22" Wire Guard, for use with conical/drop lens, Chrome
			<input type="checkbox"/> 25FWGC 25" Full wire guard (covers entire reflector), Chrome

Lamp Accessories	
Wattage	Lamp Color
<input type="checkbox"/> T26 26 Watt	<input type="checkbox"/> 27k (26W Only)
<input type="checkbox"/> T32 32 Watt	<input type="checkbox"/> 30k
<input type="checkbox"/> T42 42 Watt	<input type="checkbox"/> 35k
<input type="checkbox"/> T57 57 Watt	<input type="checkbox"/> 41k
<input type="checkbox"/> T70 70 Watt	

- Notes:
- Plug Not Available with 4 Switch Legs.
  - Plug are voltage specific.
  - Advance Mark X and Lutron Tu-Wire Ballasts Require a 2-Wire Wall Dimmer.
  - Requires a 2-Wire 0-10 Volt Dimmer in addition to the Normal Hot, Neutral and Ground.
  - Requires one control wire in addition to the normal hot, neutral & ground.

- EX = External Mount IM = Internal Mount (Consult Factory for EMI/Cord/Plug Compatibility)
- IMPORTANT REMINDER: If the lamp on the emergency circuit fails, this ballast will produce an audible sound until the lamp is replaced.
- HL Option is Voltage specific, 120V or 277V
- TU Option is 120V ONLY

# COOPER LIGHTING - METALUX®

## DESCRIPTION

The Metalux Thin Profile Undercabinet fixture provides effective task and enhancement lighting solutions for any decor. This specification grade fluorescent undercabinet series incorporates the latest Energy Efficient Technology, T5 fluorescent lamps and electronic ballasts, to efficiently improve the appearance and productivity of the illuminated environment.

The unique low profile design of the Metalux undercabinet fixture conforms to various applications such as kitchens, offices, study areas, displays, computer work centers and practically any undercounter installation where an inconspicuous light source is required.

<b>Catalog #</b>		<b>Type</b>	K
<b>Project</b>		<b>Date</b>	
<b>Comments</b>			
<b>Prepared by</b>			

## SPECIFICATION FEATURES

### A... Construction

Nominal 1" deep, heavy gauge cold rolled steel housing construction. Housing features rounded corners and no exposed fasteners. Keyhole mounting slots are located on top of housing for ease of installation. KO's for continuous row mounting. Housing available with solid metal front option.

### B... Electrical\*

Ballast are CBM/ETL Class "P" and positively secured by mounting bolts. Pressure lock lampholders. UL/CUL listed. Suitable for damp locations.

### C... Finish

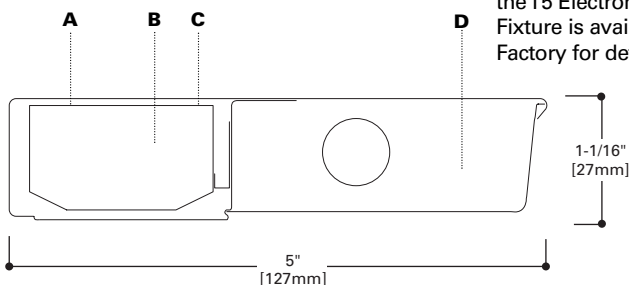
Painted after fabrication. Electrostatically applied baked white polyester powder enamel finish. Multistage cleaning cycle, iron phosphate coating with rust inhibitor. ConveyORIZED application and baking timing accurately controlled at an elevated temperature.

### D... Frame/Shielding

100% virgin acrylic, linear ribbed diffuser with 50% DR additive. Diffuser is non-yellowing, light stabilized for excellent light transmission. Diffuser can be easily removed.

### E... Warranty

A Lifetime Limited Warranty for the T5 Electronic Ballasted Fixture is available. Consult Factory for details.

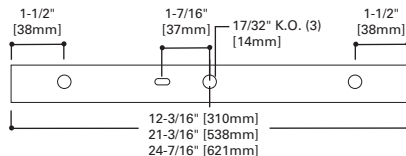
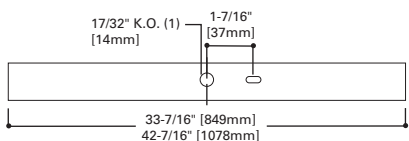


**CL108 (12")**  
**113 (21")**  
**208 (24")**  
**108113 (33")**  
**213 (42")**

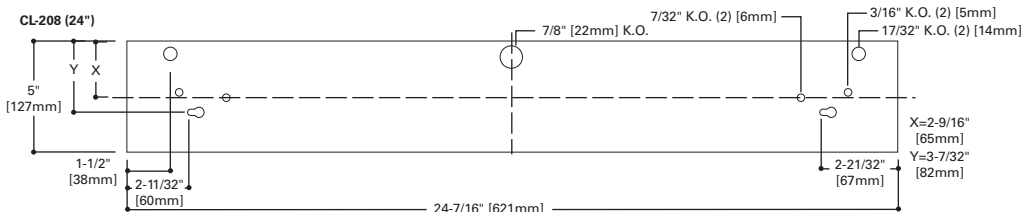
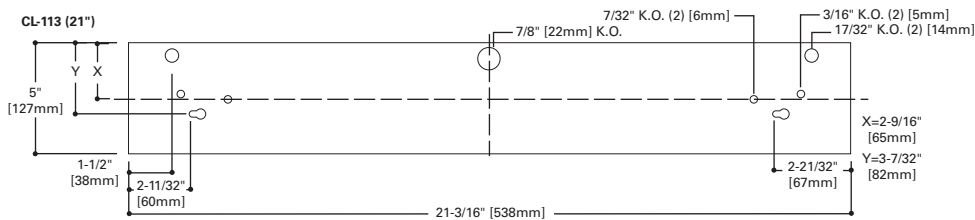
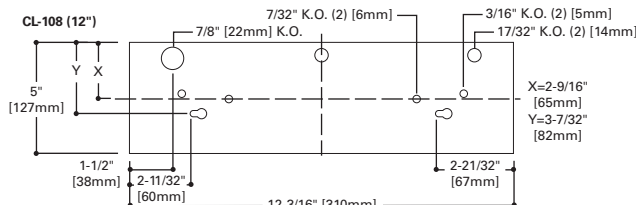
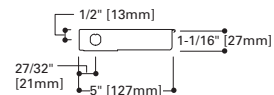
**1 OR 2 T5 LAMPS**  
**SPECIFICATION GRADE**

Low Profile  
 Undercabinet Series

## MOUNTING DATA



## LAMP CONFIGURATIONS



## ENERGY DATA

Input Watts:  
**EB Ballast & STD Lamps**  
 108 T5 (9)  
 113 T5 (14)  
 108113 T5 (23)  
 208 T5 (19)  
 213 T5 (27)

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**

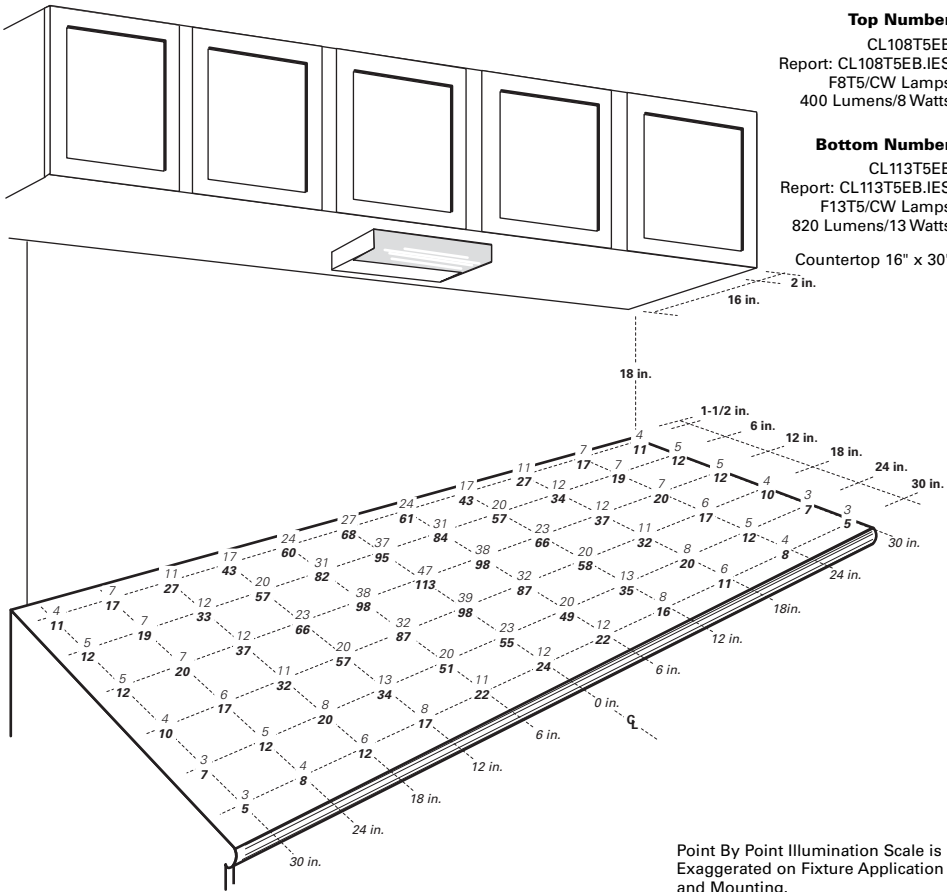
Safe and convenient means of disconnecting power.



PHOTOMETRICS

Fixture Application Illustration

MOUNTING HEIGHT 18"



**Top Number**  
CL108T5EB  
Report: CL108T5EB.IES  
F8T5/CW Lamps  
400 Lumens/8 Watts

**Bottom Number**  
CL113T5EB  
Report: CL113T5EB.IES  
F13T5/CW Lamps  
820 Lumens/13 Watts

Countertop 16" x 30"

Optional Mounting Heights

MOUNTING HEIGHT 15"

Top Number		CL108T5EB - Report: CL108T5EB.IES									
Bottom Number		CL113T5EB - Report: CL113T5EB.IES									
5	7	11	18	27	32	27	18	11	7	5	1-1/2"
11	18	28	45	63	71	63	45	28	17	11	6"
5	8	13	23	39	48	37	23	13	8	5	12"
12	20	36	65	103	118	102	65	36	20	12	18"
5	8	13	26	52	69	51	26	13	7	5	24"
12	21	41	84	140	165	139	83	40	21	12	30"
4	6	11	22	42	55	40	22	11	6	4	30" 24" 18" 12" 6" 0 6" 12" 18" 24" 30"
10	17	33	69	114	135	113	66	32	16	9	
3	5	8	13	22	27	22	14	8	5	3	
7	11	19	34	52	58	53	32	19	11	7	
2	3	5	8	11	13	11	8	5	3	2	
5	7	10	15	19	21	19	14	10	7	5	

MOUNTING HEIGHT 24"

Top Number		CL108T5EB - Report: CL108T5EB.IES									
Bottom Number		CL113T5EB - Report: CL113T5EB.IES									
4	6	9	14	18	20	18	14	9	6	4	1-1/2"
8	13	19	26	33	36	33	26	19	12	8	6"
5	7	11	16	21	24	21	16	10	7	4	12"
9	14	21	31	39	43	39	30	21	14	9	18"
5	7	11	17	23	26	23	17	11	7	4	24"
9	14	22	32	43	47	42	32	21	14	9	30" 24" 18" 12" 6" 0 6" 12" 18" 24" 30"
4	6	10	15	21	24	21	15	10	6	4	
8	13	19	29	37	41	37	29	19	13	8	
4	5	8	12	16	17	16	12	8	5	4	
7	10	16	22	28	30	28	22	16	10	7	
3	4	6	8	10	11	11	8	6	4	3	
6	8	12	15	19	19	19	15	12	8	6	

Point By Point Illumination Scale is Exaggerated on Fixture Application and Mounting.

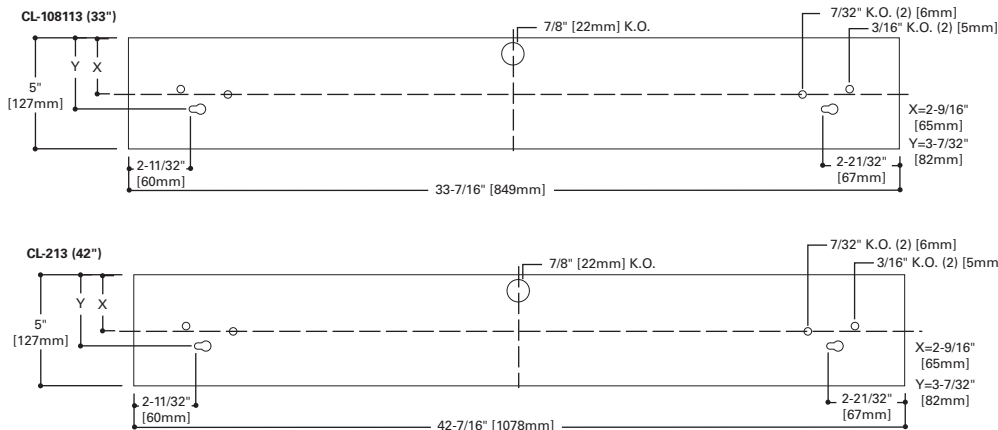
ORDERING INFORMATION (T5)

SAMPLE NUMBER: CL-113T5-EB-120V-U

<b>Housing Design</b> Blank=Lens Front OF=Opaque Front SF=Solid Metal Front	<b>Series</b> CL=Series	<b>Number of Lamps</b> 1=12", 21", 33" Fixture 2=24", 42" Fixture (Not Included)	<b>Wattage (Length)</b> 08T5=8W T5 (12", 24") 13T5=13W T5 (21", 42") 0813T5=8W and 13WT5 (33")	<b>Ballast Type</b> EB=Electronic Ballast PH=Pre-Heat Ballast	<b>Voltage</b> 120V=120 Volt	<b>Options</b> CO=Convenience Outlet SW=Rocker Switch 6CP=6" White 3-Wire Fuse (See Options Section)	<b>Packaging</b> U=Unit Pack
--	----------------------------	---	---	---	---------------------------------	--	---------------------------------

Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.

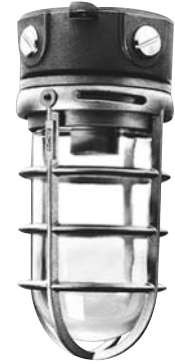
MOUNTING DATA



SHIPPING INFORMATION

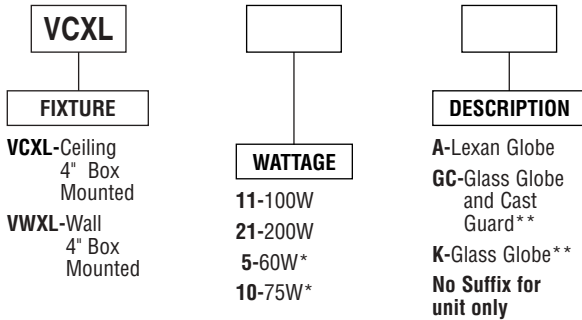
Catalog No.	Wt.
CL-108T5-EB	2 lbs.
CL-113T5-EB	4 lbs.
CL-208T5-EB	5 lbs.
CL-213T5-EB	6 lbs.
CL-108113T5-EB	6 lbs.

# ROUGHLYTE™ Series



## ORDERING INFORMATION

Catalog Number: Example: VCXL11GC



\*60W and 75W available with lexan globe only. \*\*For use with 100W and 200W units only.

## PRODUCT SPECIFICATIONS

- VCXL Roughlyte fixtures are for use on ceilings and canopies. VWXL Roughlyte fixtures are for use on walls and columns. Roughlyte fixtures guard against moisture and debris in exterior applications (for globe down mounting only).
- **Not recommended for use in hazardous locations.**
- Complete with 4" die-cast aluminum box, four side and top hole tapped 1/2" NPT (four plugs included).
- Heat and shock resistant glass or polycarbonate globe.
- Cast aluminum bayonet guard with allen head security screws.
- Sockets are pre-wired with extra long 1/2" stripped leads.
- To use VCXL units with 3/4" conduit use VK Series with VXL13 universal box.
- To use VWXL units with 3/4" conduit, use VW Series with VXL13 universal box.
- Patented.

## ACCESSORIES

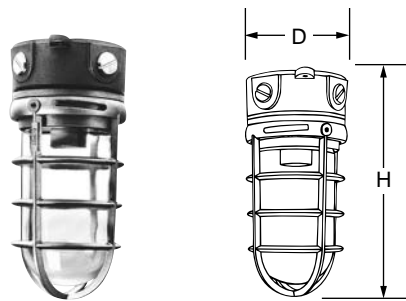
Accessories - See page 5-A

## TECHNICAL INFORMATION

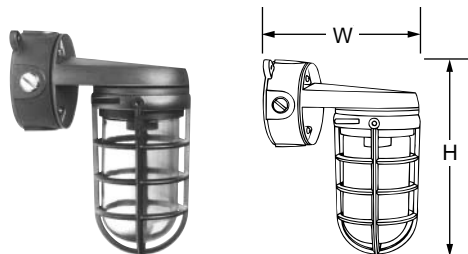
All incandescent Roughlyte ceiling and wall fixtures are not supplied with a lamp. This fixture requires a medium base incandescent A lamp. The lamp can be clear or coated.

### DIMENSIONS

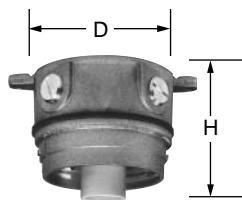
Catalog No.	Height (H)	Dia. (D)
VCXL11	3-3/4"	4-1/4"
VCXL21	3-3/4"	5-1/8"
VCXL11K	8-5/8"	4-1/4"
VCXL21K	0-3/8"	5-1/8"
VCXL11GC	9-1/8"	4-1/4"
VCXL21GC	10-7/8"	5-1/4"
VCXL5A	8-5/8"	4-1/4"
VCXL10A	10-3/8"	5-1/8"
VWXL	12-3/4"	7"
VWXL11	4-1/4"	7-1/8"
VWXL21	4-1/4"	7-7/16"
VWXL11K	9-1/4"	7-1/8"
VWXL21K	10-7/8"	7-7/16"
VWXL11GC	9-3/4"	7-1/4"
VWXL21GC	11-3/8"	7-1/2"
VWXL5A	9-1/4"	7-1/8"
VWXL10A	10-7/8"	7-7/16"



VCXL11GC



VWXL



VCXL11  
Box Mount  
Adapter

Roughlyte is a registered trademark of Stonco and is not for use in hazardous areas.

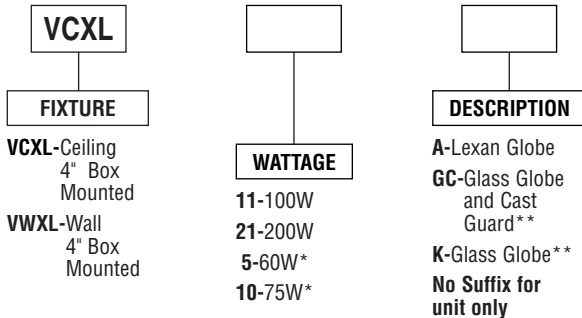


UL Wet Location Listed.  
UL File Number: E57163

# ROUGHLYTE™ Series

## ORDERING INFORMATION

Catalog Number: Example: VCXL11GC



\*60W and 75W available with lexan globe only. \*\*For use with 100W and 200W units only.

## ACCESSORIES

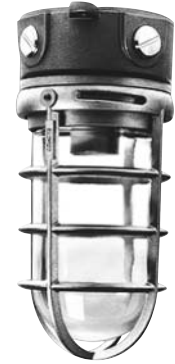
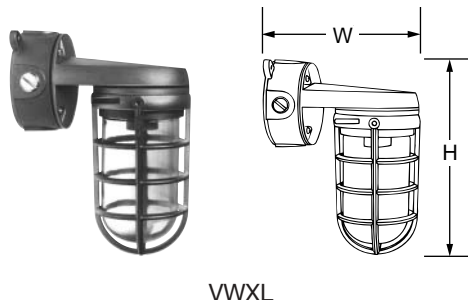
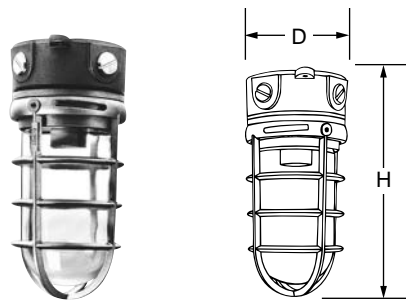
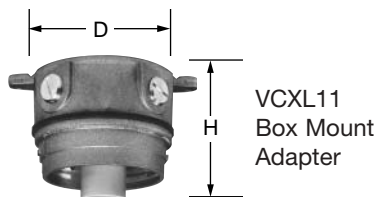
Accessories - See page 5-A

## TECHNICAL INFORMATION

All incandescent Roughlyte ceiling and wall fixtures are not supplied with a lamp. This fixture requires a medium base incandescent A lamp. The lamp can be clear or coated.

### DIMENSIONS

Catalog No.	Height (H)	Dia. (D)
VCXL11	3-3/4"	4-1/4"
VCXL21	3-3/4"	5-1/8"
VCXL11K	8-5/8"	4-1/4"
VCXL21K	0-3/8"	5-1/8"
VCXL11GC	9-1/8"	4-1/4"
VCXL21GC	10-7/8"	5-1/4"
VCXL5A	8-5/8"	4-1/4"
VCXL10A	10-3/8"	5-1/8"
VWXL	12-3/4"	7"
VWXL11	4-1/4"	7-1/8"
VWXL21	4-1/4"	7-7/16"
VWXL11K	9-1/4"	7-1/8"
VWXL21K	10-7/8"	7-7/16"
VWXL11GC	9-3/4"	7-1/4"
VWXL21GC	11-3/8"	7-1/2"
VWXL5A	9-1/4"	7-1/8"
VWXL10A	10-7/8"	7-7/16"



## PRODUCT SPECIFICATIONS

- VCXL Roughlyte fixtures are for use on ceilings and canopies. VWXL Roughlyte fixtures are for use on walls and columns. Roughlyte fixtures guard against moisture and debris in exterior applications (for globe down mounting only).
- **Not recommended for use in hazardous locations.**
- Complete with 4" die-cast aluminum box, four side and top hole tapped 1/2" NPT (four plugs included).
- Heat and shock resistant glass or polycarbonate globe.
- Cast aluminum bayonet guard with allen head security screws.
- Sockets are pre-wired with extra long 1/2" stripped leads.
- To use VCXL units with 3/4" conduit use VK Series with VXL13 universal box.
- To use VWXL units with 3/4" conduit, use VW Series with VXL13 universal box.
- Patented.

Roughlyte is a registered trademark of Stonco and is not for use in hazardous areas.



UL Wet Location Listed.  
UL File Number: E57163

CATALOG NO. \_\_\_\_\_

TYPE NO. \_\_\_\_\_

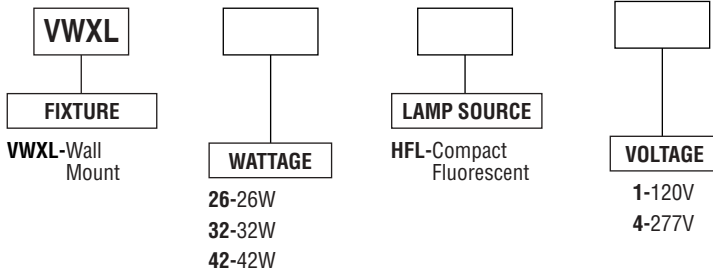
JOB NAME \_\_\_\_\_

# ROUGHLYTE™ Series 26, 32, 42 Watt (HF) Compact Fluorescent



## ORDERING INFORMATION

Catalog Number: Example: VWXL42HFL-1

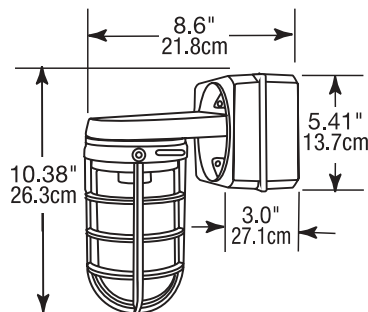


**Note:** Not for use in hazardous or classified locations. Not for recessed mounting.

## ACCESSORIES

Accessories - See page 5-A

## TECHNICAL INFORMATION



## PRODUCT SPECIFICATIONS

- Restaurants, Taverns or Night-clubs, Food Courts, Atriums or Plazas, Malls, Retail Outlets, Stores, Athletic Clubs and Facilities, Theaters, Arenas, Stadiums, Amusement Parks.
- Precision die cast aluminum electrical enclosure.
- Die cast aluminum ballast box.
- Heat and shock resistant, prismatic glass optical chamber with neoprene gasketing.
- Corrosion resistant Draplex II polyester powder finish.
- Optional designer finishes available.
- Compact fluorescent ballasts are Electronic HPF >95%, <10% THD.
- PLT four pin base GX24q-3 (26/32W), GX24q-4 (42W).
- Starting temperature: 0°F/-18°C.
- Low glare clear prismatic glass globe standard.
- Approximately 40% upright.
- UL 1598 listed for wet locations – globe down only.

Roughlyte is a registered trademark of Stonco and is not for use in hazardous areas.



UL Wet Location Listed.



## DESCRIPTION

The DMF Series is an energy efficient family of industrials that feature premium performance and durability. The industrial series incorporates heavy duty, embossed, reflectors that precisely direct and effectively control light. The versatile DMF Series can be installed using various mounting methods and numerous options and accessories are available.

The DMF Series can be utilized in simple task and area lighting to the most demanding industrial applications.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

## SPECIFICATION FEATURES

### Construction

Channel is code gauge prime cold rolled steel. Die formed with deep V-grooves for tong hanger. Die formed channel connector assures straight rows and continuity of ground through set screws. Lampholder mounting brackets are easily inserted with snap-in action.

### Electrical\*

Ballast are CBM/ETL Class "P" and positively secured by mounting bolts. Metal clad lampholders are spring loaded for turret safety. UL/CUL listed. Suitable for damp locations.

### Finish

Multistage iron phosphate pretreatment ensures maximum bonding and rust inhibitor. Lighting grade, baked white enamel finish.

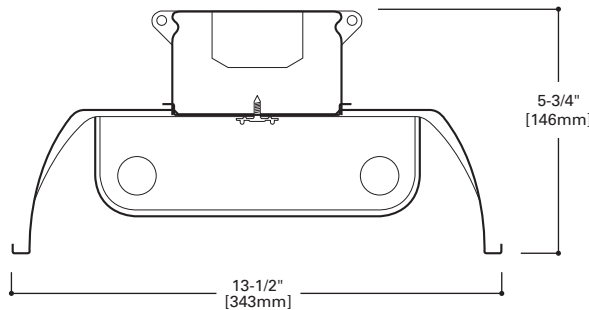
### Reflectors

Die formed prime steel, code gauge. Deep draw full width ribs formed with one press stroke. Side flanges lend strength with upward turn. Easily cleaned. Baked white enamel 13-1/2" width. Four foot sections. Reflectors secured by positive retaining screw. Reflector aligners provided. Standard with 20% uplight (DMF). Closed top reflector (DCMF). Optional industrial fixtures are available incorporating silver technology enhancements. (SilverLining)

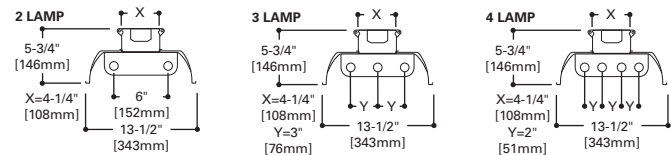


**DMF**  
232  
332  
432

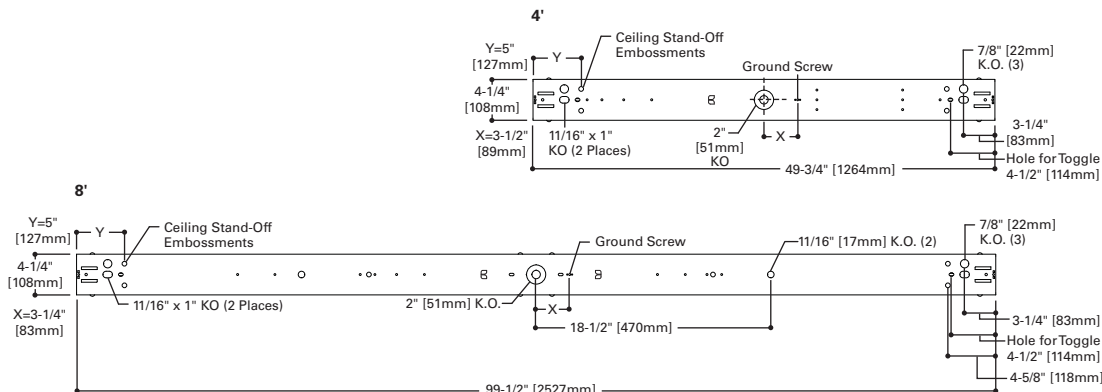
**4' OR 8' INDUSTRIAL**  
**2, 3 OR 4 LAMP**  
Heavy Duty Industrial



## LAMP CONFIGURATIONS



## MOUNTING DATA



## ENERGY DATA

Input Watts:  
**ES Ballast & STD Lamps**  
232 (71), 332 (108), 432 (142)

Luminaire Efficacy Rating  
**LER = FI-78**  
Catalog Number: DMF-232

Yearly Cost of 1000 lumens, 3000 hrs at .08 KWH = \$3.08

\*Reference the lamp/ballast data in the Technical Section for specific lamp/ballast requirements.

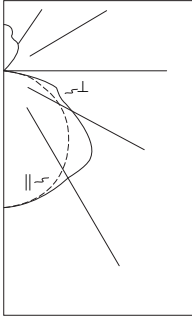
LAMPS CONTAIN MERCURY. DISPOSE ACCORDING TO LOCAL, STATE OR FEDERAL LAWS

**LINEAR DISCONNECT**  
Safe and convenient means of disconnecting power.





PHOTOMETRICS



**DMF-232**  
 Electronic Ballast  
 F32T8/35K Lamps  
 2850 Lumens  
 Spacing criterion:  
 (||) 1.3 x mounting  
 height, (⊥) 1.4 x  
 mounting height  
 Efficiency 90.8%  
 Test Report:  
 DMF232.IES  
 LER = FI-78  
 Yearly Cost of 1000  
 lumens, 3000 hrs at  
 .08 KWH = \$3.08

**Coefficients of Utilization**

rc	Effective floor cavity reflectance																									
	80%				70%				50%				30%				10%				0%					
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10			
<b>RCR</b>																										
0	105	105	105	105	100	100	100	100	93	93	93	86	86	86	79	79	79	76	76	76	76	76	76	76	76	76
1	95	91	87	84	91	88	84	81	81	78	76	75	73	71	70	68	66	64	64	64	64	64	64	64	64	64
2	87	79	73	68	83	76	71	66	71	66	62	66	62	59	61	58	55	53	53	53	53	53	53	53	53	53
3	79	70	62	57	76	67	61	55	62	57	52	58	53	50	54	50	47	44	44	44	44	44	44	44	44	44
4	72	61	54	48	69	59	52	47	55	49	44	51	46	42	48	44	40	38	38	38	38	38	38	38	38	38
5	66	54	46	40	63	52	45	39	49	42	37	45	40	35	42	37	34	31	31	31	31	31	31	31	31	31
6	60	48	40	34	57	46	39	33	43	37	32	40	35	30	38	33	29	27	27	27	27	27	27	27	27	27
7	55	43	35	29	53	42	34	29	39	32	28	36	31	26	34	29	25	23	23	23	23	23	23	23	23	23
8	51	38	31	25	49	37	30	25	35	28	24	32	27	23	30	25	22	20	20	20	20	20	20	20	20	20
9	47	34	27	22	45	33	26	21	31	25	20	29	23	19	27	22	19	17	17	17	17	17	17	17	17	17
10	43	31	24	19	41	30	23	19	28	22	18	26	21	17	25	20	16	15	15	15	15	15	15	15	15	15

**Zonal Lumen Summary**

Zone	Lumens	%Lamp	%Fixture
0-30	1016	17.8	19.6
0-40	1703	29.9	32.9
0-60	3238	56.8	62.5
0-90	4330	76.0	83.7
90-180	846	14.8	16.3
0-180	5176	90.8	100.0

**Candela**

Angle	Along	45°	Across ⊥
0	1278	1278	1278
10	1258	1264	1268
20	1195	1214	1228
30	1092	1133	1180
40	952	1039	1174
50	781	972	1075
60	582	817	724
70	367	472	553
80	157	251	138
90	15	30	21
100	31	65	50
110	96	18	38
120	169	45	20
130	240	140	64
140	304	244	173
150	358	286	286
160	398	369	311
170	424	426	420
180	434	434	434

ORDERING INFORMATION

SAMPLE NUMBER: DMF-232-120V-EB81-U

<p><b>Tandem</b> Blank=4' Length 8T=8' Length</p> <p><b>Series</b> DMF= Apertured Reflector DCMF= Closed Top Reflector</p> <p><b>Lamp Spacing</b> Blank=Standard Spacing N=Narrow Spacing for 2 Lamp Only (10% upright)</p>	<p><b>Silver Reflector</b> SS= Silver-Lining Reflector</p> <p><b>Wattage (Length)</b> 32=32W T8 (48")</p> <p><b>Options</b> GL=Single Element Fuse GM=Double Element Fuse EL=Emergency Installed</p>	<p><b>Number of Lamps</b> 2, 3 or 4 Lamps (Not included)</p> <p><b>Voltage</b><sup>(1)</sup> 120V=120 Volt 277V=277 Volt 347V=347 Volt UNV=Universal Voltage 120-277</p>	<p><b>Ballast Type</b><sup>(1)</sup> EB8 =T8 Electronic Instant Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1, 2 or 3 EB8 /PLUS= T8 Electronic Instant Start. High Ballast Factor &gt;1.13. Total Harmonic Distortion &lt; 20% No. of Ballast 1, 2 or 3 ER8 =T8 Electronic Program Rapid Start. Total Harmonic Distortion &lt; 10% No. of Ballast 1, 2 or 3</p>	<p><b>Options</b> RIF1=Radio Interference Suppressor 6-3/18 SJT-C&amp;P-515P=Cord &amp; Plug (120V) 6-3/18 SJT-C&amp;P-L715P=Cord &amp; Plug (277V) PI/CPI=Plug-In Option TILW=Tandem In-Line Wiring Option (Consult TILW Option Catalog Page) POX=Porlux Finish (See options &amp; accessories)</p>	<p><b>Packaging</b> U=Unit Pack 4B=4 Bulk</p>
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ACCESSORIES

(Order Separately)

- A1B/Spacer-U=Spacer 1-1/2" to 2-1/2" from ceiling (Use 2 per fixture)
- ATG-DIF-4-U=Tong Hanger (Use 2 per fixture)
- SCF=Fixed Stem Set (Specify Length)
- SCS=Swivel Stem Set (Specify Length)
- SCA=Adjustable 48" Stem Set
- AYC-Chain/Set-U=Chain Hanger Set (Use 1 set per fixture)
- WG/DIF4FT-U=Wire Guard
- GYM GUARD, GG-DIF=Wire Gym Guard
- MECL-DIF/SL-48-U=Metal Egg Crate Louver
- MECL-DIF/SL-96-U=Metal Egg Crate Louver
- DIF2 LONG CONN (PREPAINTED)=Long Connector
- DIF CLOSED END PLATE=Closed End Plate

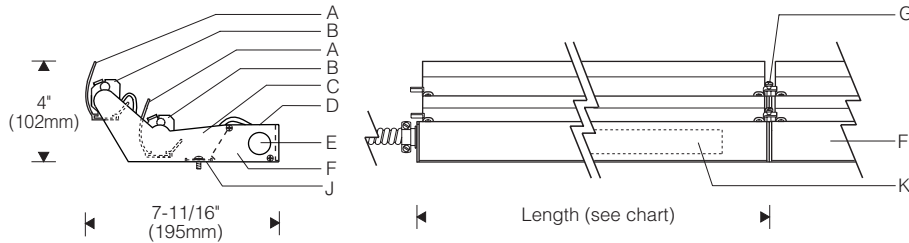
SHIPPING INFORMATION

Catalog No.	Wt.
DMF-232	15 lbs.
8TDMF-232	30 lbs.
DMF-332	25 lbs.
DMF-432	25 lbs.

NOTES: <sup>(1)</sup>Products also available in non-US voltages and frequencies for international markets.

Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.

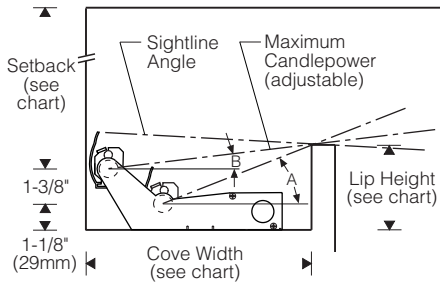
Style 307 1:8 Scale



Lamp Length	Luminaire Length
1 x 2'	23-1/16" (586mm)
1 x 3'	34-7/8" (886mm)
1 x 4'	46-11/16" (1186mm)
1 x 5'	58-1/2" (1486mm)
2 x 3'	69-1/2" (1765mm)
2 x 4'	93-1/8" (2365mm)
2 x 5'	116-5/8" (2963mm)



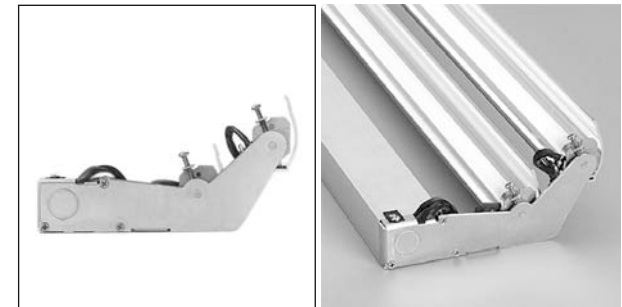
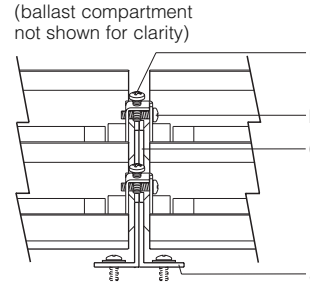
Cove



Cove Dimensions

Sightline	0° (horiz. cutoff)	5°	10°
Width (inside)	11" (280mm)	9" (230mm)	8" (205mm)
Lip (inside)	4" (102mm)	3-1/4" (83mm)	2-5/8" (67mm)
Setback (varies)	Recommended minimum: 18" T5, 24" T5HO		
∠ A*	20°	20°	17°
∠ B*	8°	5°	5°

Joint 1:4 Scale



Note: Finish interior of cove matte white for best results.

\*Adjustable aiming, lowest angle listed.

Specifications

- A** Specular extruded aluminum reflector
- B** Stainless steel lamp-holder/support brackets
- C** Aluminum sidearm with mounting tab
- D** Extruded aluminum ballast/wireway channel cover
- E** Conduit entry (one each end, conduit and connector by others)
- F** Extruded aluminum ballast/wireway compartment
- G** Rotation locking screw
- H** Joiner/alignment screw
- J** Mounting tab (fastener by others)
- K** Integral electronic ballast

Finish:

Reflectors – extruded high purity aluminum with clear anodized specular finish. Sidearms and ballast/wireway compartment – mill finish aluminum. All luminaire hardware – stainless steel.

Mounting:

Lay-in installation requires only one fastener per joint (by others). Luminaires can be mounted individually or joined together to form a continuous row.

Reflector aiming is adjustable and is fixed in position by rotation locking screws at each sidearm. When mounted in a continuous row, joiner screws lock each row of reflectors together allowing all in the row to be aimed together. Each row of reflectors is aimed independently.

Electrical:

Use 90°C wire for supply connections.

Integral electronic HPF thermally protected class P ballast with end-of-life protection. Ballast/wireway compartment includes

one conduit entry at each end. Channel cover removes for access to ballast and wiring. Luminaires may be butted end-to-end (connectors by others) for through wiring. Optional #12 AWG prewired modular through wiring with quick connectors.

Optional electronic dimming ballast; compatible dimmer switch required (by others). Consult sales representative for compatibility and specifications.

Optional integral emergency battery operates one lamp. Separate unswitched supply is required.

For complete ballast specifications, see Accessories Section.

Standard:

UL listed or CSA certified for damp locations (Style 124 painted model with lens recommended for damp locations).

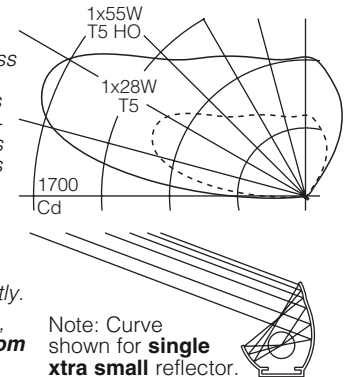
Features

- Two independently aimed reflectors – greater versatility
- T5 fluorescent – precise optical control for unequalled projection of light from perimeter coves
- Adjustable – each row of reflectors joins and aims together; rotation locking screws secure position
- Integral electronic ballast, thru wiring for easy installation

Performance

Each reflector consists of two parabolic reflector sections to drive light across the ceiling from one edge. An elliptical section shields the lamp from normal viewing angles and redirects its light to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity. Reflectors aim independently.

For complete photometrics, visit [thelightingquotient.com](http://thelightingquotient.com)



Note: Curve shown for single xtra small reflector.



Cradle to Cradle Certified<sup>CM</sup> is a certification mark licensed by the Cradle to Cradle Products Innovation Institute.



U.S. Patents 5,550,725 and D468,457 S; EPO 0710796; U.K. Patent 3005837 or GB RD 3005837.

**To form a Catalog Number**

F | 3 | 0 | 7 | - | T | | | | - | S | - | 0 | 0 | - | | | | | | | |  
 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8

**1 Source**

F = Linear fluorescent

**2 Style**

307 = Dual xtra small concealed, integral ballast

**3 Lamp**

**Note:** To order by overall row length, enter **ROW CODE** in place of Lamp Code below (see Row Charts on page C-22.2). Row Code specifies a row complete with all necessary reflectors and ballasts.

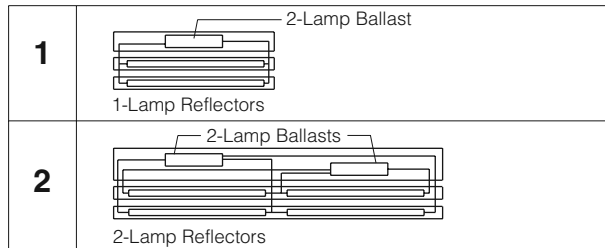
T | | | | = **Lamp Code** (to specify individual units)

| | | | = **Lamp Wattage** (see chart below)

| | | | = **Reflector Configuration**, specify 1 or 2 (see chart below)

Example: **T228** = four 28W T5 lamps in two nominal 8' reflectors; two 2-lamp ballasts

*Reflector Configuration*



Lamp Wattage	Lamp Length	Lamp Number
T5 Fluorescent		
14	2'	F14T5
21	3'	F21T5
28	4'	F28T5
35	5'	F35T5
T5 HO Fluorescent*		
24	2'	F24T5/HO
39	3'	F39T5/HO
55	4'	F54T5/HO
80	5'	F80T5/HO

For complete lamp and ballast information, see Accessories Section. Standard T5 and T5HO lamp color is 3000K/80+ CRI.

Project: \_\_\_\_\_

Type: \_\_\_\_\_

**4 Mounting**

S = Sidearms with mounting tabs for cove mounting

**5 Finish**

00 = Bright anodized reflectors with mill finish ballast compartment

**6 Voltage/Ballast**

*Electronic*                      *Dimming\**  
 1 = 120V                          T = 120V  
 2 = 277V                          V = 277V  
 3 = 347V (Canada)

\* Consult sales representative for dimming 5' lamps (lamp codes **Tx35, Tx80**). Availability for wattages and voltages varies with ballast manufacturer and control type – see [thelightingquotient.com](http://thelightingquotient.com) for additional dimming specifications and limitations.

**7 Option** (see Accessories Section for specifications)

- 00 = No options
- 0E = Integral emergency battery pack with indicator lamp and test button. Operates one lamp. Available in nominal 4', 6' and 8' units only (lamp codes **T128, T221, T228, T155, T239** and **T255**).
- 0K = Prewired modular #12 AWG through wiring with quick connectors
- 0W = Two circuit wiring for switching front reflector separate from back reflector  
 Available in nominal 4', 5', 6' and 8' units only (lamp codes **T128, T135, T221, T228, T155, T180, T239** and **T255**). Not for use with 0E option (battery pack) or with T, V voltage (dimming); consult factory.
- EK = Combination of emergency battery pack and prewired modular through wiring as described above
- XX = For modification not listed, include detailed description. Consult factory prior to specification.

**8 Destination Requirement**

- 0 = UL listed or CSA certified for U.S.
- J = UL listed or CSA certified for Canada

**Example**

**F307 - T221 - S - 00 - 1 - 000**

Dual xtra small concealed fluorescent unit consisting of two nominal 6' reflectors with four 21W T5 lamps. Two integral 120V electronic 2-lamp ballasts. Sidearms with mounting tabs. UL listed or CSA certified for U.S.

**Accessories**

Order separately. See Accessories Section for specifications.

AFK000X | | = Ballast fuse kit  
 0 = U.S.  
 J = Canada



**To order by Row Code - T5 lamps**

When the Style F307 dual xtra small concealed or F308 small/xtra small concealed T5 fluorescent is run continuously in **straight** coves, **elliptipar** offers the option of specifying and ordering the entire row as one catalog number. Ordering by row eliminates the need to calculate length, type and quantity of reflectors.

Steps to specify Row Code:

1. Determine clear inside length of cove.
2. Round up to nearest foot and find the nominal row length in chart.
3. Determine what lengths/wattages of lamps will be used and select the corresponding lamp combination codes.

**Example:** If only 3' and 4' lamps are to be used on the project, specify row codes ending with **A**, **B** and/or **D** only.

4. If for a given nominal row length a preferred lamp combination is not listed, select the next shorter row that is available in the desired lamp combination.
5. Once the nominal row length and lamp combination has been found in the chart, note the actual overall row length (last column).
6. Consider the unlighted length at each end of the row (subtract the overall row length from the clear inside length, and divide the remainder by two). It is generally recommended that the unlighted length at each end be between 6" and 12".
7. Enter the four character Row Code in place of the Lamp Code described on page C-21.1 for F307 or C-22.1 for F308. The remainder of the catalog number is formed as shown on pages C-21.1 and C-22.1.

**Features**

- Time saving – simplifies specification and ordering
- One catalog number – includes all necessary reflectors to install row
- Assured fit – all you need is the clear inside length of the cove

**3 Row Code**

**Note:** Enter row code in place of Lamp Code described on page C-19.1.

**Row Code**

**Lamp Combination\***

- A** = All nominal 3' lamps
- B** = All nominal 4' lamps
- C** = All nominal 5' lamps
- D** = Nominal 3' and 4' lamps
- F** = Nominal 3' and 5' lamps
- G** = Nominal 4' and 5' lamps

**Nominal Row Length** in feet, between 3' and 50'\*\*

- S** = T5 fluorescent
- V** = T5/HO fluorescent

\* Not all lamp combinations are available for each nominal row length (see chart).

\*\* Nominal row lengths over 50' can be formed by combining shorter row lengths (Example: a nominal 60' row can be ordered as two nominal 30' rows).

**Example**

**F307 - S15A - S - 00 - 2 - 000**

Nominal 15' long row of Style 307 dual xtra small concealed T5 fluorescent using only nominal 3' (21W) lamps. Row includes two nominal 6' luminaires for use with four 3' lamps each, one nominal 3' luminaire for use with two 3' lamps and integral 277V electronic ballasts. Overall row length is 14' 5-7/8".

Nominal Row Length (feet)	Lamp Combination	Nominal 3' Luminaire (2 x nominal 3' lamp)	Nominal 4' Luminaire (2 x nominal 4' lamp)	Nominal 5' Luminaire (2 x nominal 5' lamp)	Nominal 6' Luminaire (4 x nominal 3' lamps)	Nominal 8' Luminaire (4 x nominal 4' lamps)	Nominal 10' Luminaire (4 x nominal 5' lamps)	Overall Row Length
03	A	1						2' 10-7/8"
04	B		1					3' 10-11/16"
05	C			1				4' 10-1/2"
06	A				1			5' 9-1/2"
07	D	1	1					6' 9-9/16"
08	B					1		7' 9-1/8"
08	F	1		1				7' 9-3/8"
09	A	1			1			8' 8-3/8"
09	G		1	1				8' 9-3/16"
10	C						1	9' 8-5/8"
10	D		1		1			9' 8-3/16"
11	D	1				1		10' 8"
11	F			1	1			10' 8"
12	A				2			11' 7"
12	B		1			1		11' 7-13/16"
13	D	1	1		1			12' 7-1/16"
13	F	1					1	12' 7-1/2"
13	G			1		1		12' 7-5/8"
14	D				1	1		13' 6-5/8"
14	F	1		1	1			13' 6-7/8"
14	G		1				1	13' 7-5/16"
15	A	1			2			14' 5-7/8"
15	C			1			1	14' 7-1/8"
15	D	1	1			1		14' 6-11/16"
16	B					2		15' 6-1/4"
16	F				1		1	15' 6-1/8"
17	D	1			1	1		16' 5-1/2"
17	F			1	2			16' 5-1/2"
17	G		1	1		1		16' 6-5/16"
18	A				3			17' 4-1/2"
18	D		1		1	1		17' 5-5/16"
18	F	1		1			1	17' 6"
18	G					1	1	17' 5-3/4"
19	D	1				2		18' 5-1/8"
19	F	1			1		1	18' 5"
19	G		1	1			1	18' 5-13/16"



To order by Row Code - T5 lamps

Project: \_\_\_\_\_

Type: \_\_\_\_\_

Nominal Row Length (feet)	Lamp Combination	Nominal 3' Luminaire (2 x nominal 3' lamp)	Nominal 4' Luminaire (2 x nominal 4' lamp)	Nominal 5' Luminaire (2 x nominal 5' lamp)	Nominal 6' Luminaire (4 x nominal 3' lamps)	Nominal 8' Luminaire (4 x nominal 4' lamps)	Nominal 10' Luminaire (4 x nominal 5' lamps)	Overall Row Length
20	B		1				2	19' 4-15/16"
20	C						2	19' 5-1/4"
21	A	1			3			20' 3-3/8"
21	D	1	1		1	1		20' 4-3/16"
21	F			1	1		1	20' 4-5/8"
21	G			1		2		20' 4-3/4"
22	D		1		3			21' 3-3/16"
22	F				2		1	21' 3-5/8"
22	G		1			1	1	21' 4-7/16"
23	D	1	1			2		22' 3-13/16"
23	F	1					2	22' 4-1/8"
23	G			1		1	1	22' 4-1/4"
24	A				4			23' 2"
24	B					3		23' 3-3/8"
24	F	1		1	1			23' 3-1/2"
24	G		1			2		23' 3-15/16"
25	C			1			2	24' 3-3/4"
25	D	1			1	2		24' 2-5/8"
26	D		1		1	2		25' 2-7/16"
26	F				1		2	25' 2-3/4"
26	G					2	1	25' 2-7/8"
27	A	1			4			26' 0-7/8"
27	D	1				3		26' 2-1/4"
27	F			1	2		1	26' 2-1/8"
27	G		1	1		1	1	26' 2-15/16"
28	B		1			3		27' 2-1/16"
28	F	1		1			2	27' 2-5/8"
28	G					1	2	27' 2-3/8"
29	D	1	1		1	2		28' 1-5/16"
29	F	1			1		2	28' 1-5/8"
29	G		1	1			2	28' 2-7/16"
30	A				5			28' 11-1/2"
30	C						3	29' 1-7/8"
30	D			1	3			29' 0-7/8"
31	D	1	1			3		30' 0-15/16"
31	F			1	1		2	30' 1-1/4"
31	G			1		2	1	30' 1-3/8"

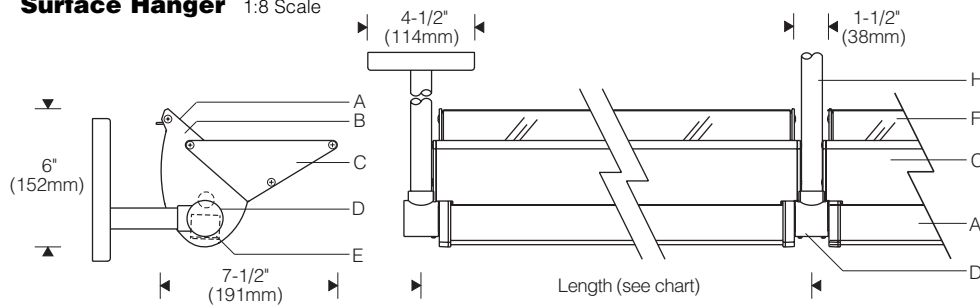
Nominal Row Length (feet)	Lamp Combination	Nominal 3' Luminaire (2 x nominal 3' lamp)	Nominal 4' Luminaire (2 x nominal 4' lamp)	Nominal 5' Luminaire (2 x nominal 5' lamp)	Nominal 6' Luminaire (4 x nominal 3' lamps)	Nominal 8' Luminaire (4 x nominal 4' lamps)	Nominal 10' Luminaire (4 x nominal 5' lamps)	Overall Row Length
32	A	1					5	31' 10-3/8"
32	B					4		31' 0-1/2"
32	D	1			1	3		31' 11-3/4"
32	F				2		2	31' 0-1/4"
32	G		1			1	2	31' 1-1/16"
33	D		1		1	3		32' 11-9/16"
33	F	1					3	32' 0-3/4"
33	G			1		1	2	32' 0-7/8"
34	D	1				4		33' 11-3/8"
34	F	1		1	1		2	33' 0-1/8"
34	G					3	1	33' 0"
35	A				6			34' 9"
35	B		1			4		34' 11-3/16"
35	C			1			3	34' 0-3/8"
36	D	1	1		1	3		35' 10-7/16"
36	G			1		4		35' 11"
37	D				1	4		36' 10"
37	F				3		2	36' 9-3/4"
37	G					1	3	36' 11"
38	A	1			6			37' 7-7/8"
38	D	1	1			4		37' 10-1/16"
38	G		1	1			3	37' 11-1/16"
39	B						5	38' 9-5/8"
39	C						4	38' 10-1/2"
40	D	1			1	4		39' 8-7/8"
40	F			1	1		3	39' 9-7/8"
40	G			1		2	2	39' 10"
41	A				7			40' 6-1/2"
41	D		1		1	4		40' 8-11/16"
41	F				2		3	40' 8-7/8"
41	G		1			1	3	40' 9-11/16"
42	D	1				5		41' 8-1/2"
42	F	1					4	41' 9-3/8"
42	G		1	1		3	1	41' 9-3/16"
43	B		1				5	42' 8-5/16"
43	F				4		2	42' 7-1/4"
43	G		1				4	42' 9-3/16"

Nominal Row Length (feet)	Lamp Combination	Nominal 3' Luminaire (2 x nominal 3' lamp)	Nominal 4' Luminaire (2 x nominal 4' lamp)	Nominal 5' Luminaire (2 x nominal 5' lamp)	Nominal 6' Luminaire (4 x nominal 3' lamps)	Nominal 8' Luminaire (4 x nominal 4' lamps)	Nominal 10' Luminaire (4 x nominal 5' lamps)	Overall Row Length
44	A	1					7	43' 5-3/8"
44	C						4	43' 9"
44	D	1	1		1	4		43' 7-9/16"
45	D				1	5		44' 7-1/8"
45	F					1		44' 8"
45	G						2	44' 8-1/8"
46	D	1	1			5		45' 7-3/16"
46	F			1	2		3	45' 7-3/8"
46	G		1	1		1	3	45' 8-3/16"
47	A				8			46' 4"
47	B						6	46' 6-3/4"
47	F	1			1		4	46' 7-7/8"
47	G					1	4	46' 7-5/8"
48	D	1			1	5		47' 6"
48	F	1			1		4	47' 6-7/8"
48	G		1	1			4	47' 7-11/16"
49	C						5	48' 7-1/8"
49	D				3	4		48' 5"
50	A	1			8			49' 2-7/8"
50	D	1				6		49' 5-5/8"
50	F			1	1		4	49' 6-1/2"
50	G			1		2	3	49' 6-5/8"

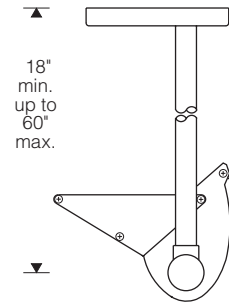




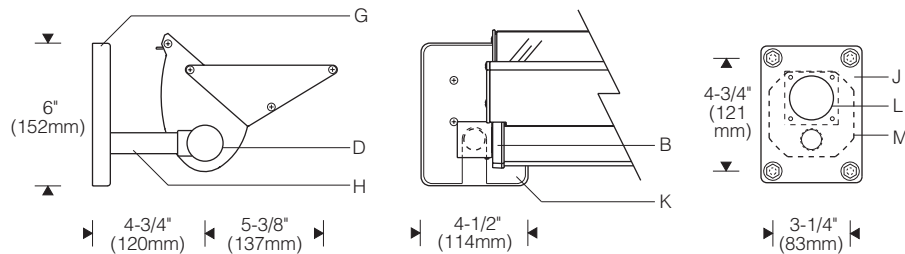
**Surface Hanger** 1:8 Scale



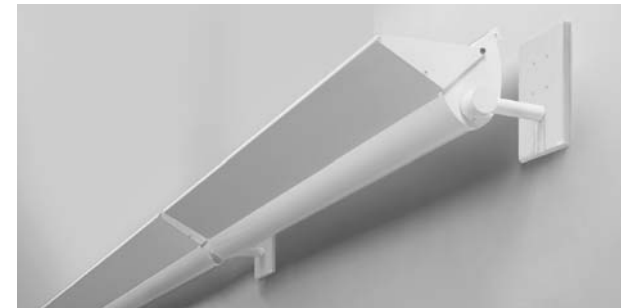
**Pendant Hanger**



**Mounting Plate**



Lamp Length	Length (center to center of hubs)
1 x 2'	25-1/4" (640mm)
1 x 3'	37" (940mm)
1 x 4'	48-3/4" (1240mm)
1 x 5'	60-5/8" (1540mm)
2 x 3'	72" (1830mm)
2 x 4'	96" (2440mm)



**Specifications**

- A** Specular extruded aluminum reflector/housing
- B** Die-cast aluminum end plates
- C** Extruded aluminum visor with stamped end plates
- D** Aluminum hub with locking set screws
- E** Integral electronic ballast/internal wireway
- F** UV and impact resistant acrylic snap-on lens with silicone gasket
- G** Surface or pendant hangers (ordered separately)
- H** Tubular steel stem or arm
- J** Die-cast aluminum mounting plate (1/4-20 fasteners by others)
- K** Aluminum cover plate (conceals fasteners and outlet box)
- L** Outlet box access opening (electrical feed)
- M** Recessed outlet box (by others)

**Finish:**

Semi-gloss white housing, end plates and visor. Painted surfaces – 6 stage pretreatment and electrostatically applied thermoset polyester powder coating for stable, long lasting and corrosion resistant finish. Reflector – extruded high purity aluminum with clear anodized specular finish. All luminaire hardware – stainless steel. Snap-on lens – composite of impact resistant and UV stabilized acrylic for easy maintenance.

**Mounting:**

Surface or pendant hangers **ordered separately**; specify end kit or intermediate hangers. Hangers include aluminum mounting plate, cover plate and 1-1/2" dia. x 1-1/2" aluminum hub with 7/8" O.D. steel arm/stem. 1/4-20 mounting fasteners by others. Suitable backing structure required – allow 3 lbs/ft (21.6kg/m) (8' unit = 24 lbs). Reflector aiming is adjustable – locks with set screws.

**Electrical:**

Use 90C° wire for supply connections and through wire. Electrical feed hanger mounts over recessed outlet box (by others). Locate electrical feed at end of row. Internal wireway allows supply wiring to be fed through mounting hub to adjacent units. Integral electronic HPF thermally protected class P ballast with end-of-life protection. Optional electronic dimming ballast; compatible dimmer switch required (by others). Consult sales representative for compatibility and specifications. Optional integral emergency battery operates one lamp. Separate unswitched supply is required. For complete ballast specifications, see Accessories Section.

**Standard:**

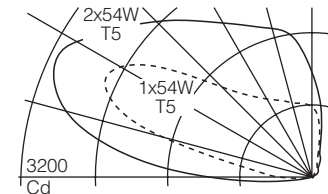
UL listed or CSA certified for damp locations.

**Features**

- Reflector optimized for T5 – projects light across ceilings with unequaled uniformity from minimal setbacks
- Powerful – single or dual T5HO lamps in cross section
- Extruded visor provides shielding – snap-on acrylic lens
- Integral electronic ballast – internal wireway for thru wiring
- Optional dimming, emergency battery pack

**Performance**

Two parabolic reflector sections drive light across the ceiling from one edge. An elliptical section shields the lamp from normal viewing angles and redirects its light to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity.

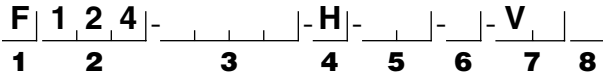


Adjustable – max. Cd shown aimed 25° above horizontal.

For complete photometrics, visit [thelightingquotient.com](http://thelightingquotient.com)



To form a Catalog Number



1 Source

F = Linear fluorescent

2 Style

124 = Medium smooth surface, integral ballast

3 Lamp

T5 Fluorescent Lamp Code

Lamp Wattage (see chart below)

Lamp Configuration

- T1 = Single-lamp cross section, 1-lamp in length
- T2 = Single-lamp cross section, 2-lamp in length
- D2 = Dual-lamp cross section, 1-lamp in length
- D4 = Dual-lamp cross section, 2-lamp in length

Example: D255 = Nominal 4' (1.2m) housing with dual (2) 54W T5HO lamps

Length (nominal)	T5		T5HO	
	Code	Lamp(s)	Code	Lamp(s)
T5 Fluorescent				
2' (0.6m)	T114	1 x F14T5	T124	1 x F24T5/HO
	D214	2 x F14T5	D224	2 x F24T5/HO
3' (0.9m)	T121	1 x F21T5	T139	1 x F39T5/HO
	D221	2 x F21T5	D239	2 x F39T5/HO
4' (1.2m)	T128	1 x F28T5	T155	1 x F54T5/HO
	D228	2 x F28T5	D255	2 x F54T5/HO
5' (1.5m)	T135	1 x F35T5	T180	1 x F80T5/HO
	D235	2 x F35T5	D280	2 x F80T5/HO
6' (1.8m)	T221	2 x F21T5	T239	2 x F39T5/HO
	D421	4 x F21T5	D439	4 x F39T5/HO
8' (2.4m)	T228	2 x F28T5	T255	2 x F54T5/HO
	D428	4 x F28T5	D455	4 x F54T5/HO

For complete lamp and ballast information, see Accessories Section. Standard T5 lamp color is 3000K/80+ CRI.

Project: \_\_\_\_\_

4 Mounting

H = For use with accessory surface or pendant hub mounting hangers.

Note: Order hangers separately. Specify end kit or intermediate hanger.

5 Finish

02 = Semi-gloss white

99 = Custom RAL or computer matched color to be specified, consult sales representative

6 Voltage/Ballast

- |                    |           |
|--------------------|-----------|
| Electronic         | Dimming** |
| 1 = 120V           | T = 120V  |
| 2 = 277V           | V = 277V  |
| 3 = 347V (Canada)* |           |

\* Consult sales representative for availability of 347V.

\*\* Consult sales representative for dimming 5' lamps (lamp codes T135, D235, T180, D280). Availability for wattages and voltages varies with ballast manufacturer and control type - see [thelightingquotient.com](http://thelightingquotient.com) for additional dimming specifications and limitations.

7 Option

V0 = Cutoff visor included, no other option

VE = Integral emergency battery pack with indicator lamp and test button. Not available in 2' and 3' units. Operates one lamp. Note: Requires unswitched feed to battery (by others).

VP = Natatorium (pool) use

VX = For modification not listed, include detailed description. Consult factory prior to specification.

Note: Cutoff visor included with all options.

8 Destination Requirement

0 = UL listed or CSA certified for U.S.

J = UL listed or CSA certified for Canada

Example

F124 - D255 - H - 02 - 2 - V00

Medium smooth surface fluorescent for use with dual (2) 54W T5HO lamps in nominal 4 foot reflector. For use with accessory hub hangers. Semi-gloss white powder coat finish. Integral 2-lamp 277V electronic ballast. Cutoff visor included. UL listed or CSA certified for U.S.

Order end kit and intermediate mounting hangers separately.

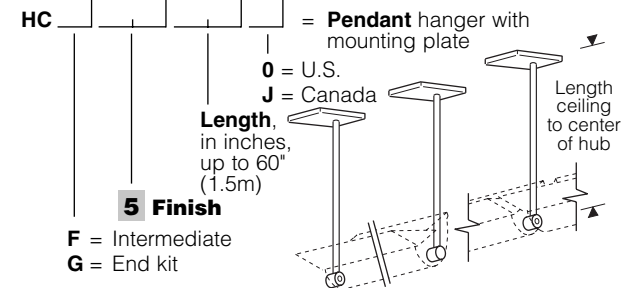
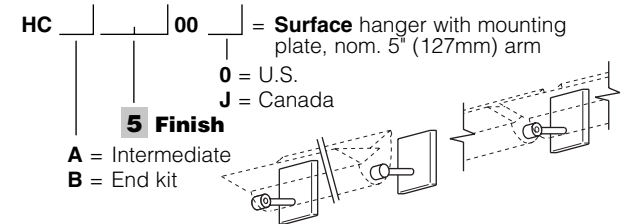
Type: \_\_\_\_\_

Hangers

Order separately. See Accessories Section for specifications. Hangers include mounting plate, cover, 7/8" (22mm) O.D. tubular stem/arm and hub. End kit includes one electrical feed end hub and one non-electrical end hub. Intermediate hanger includes single non-electrical joiner hub.

Note: Electrical feed must be located at an end of row.

For individually mounted luminaire, order one end kit. For a continuous row, order one end kit and one intermediate hanger for each additional luminaire in the row. Example: two rows of four reflectors requires 2 end kits and 6 intermediate hangers.



AMS | | | | 00 | = Surface mounting and splice box

0 = U.S.  
J = Canada

Finish: 02 white, 06 dark bronze, 07 silver, 08 semi-gloss black, 12 green

Accessories

Order separately. See Accessories Section for specifications.

AFK000X | | | = Ballast fuse kit

0 = U.S.  
J = Canada



**DESCRIPTION**

Recessed lens downlight with 4 inch aperture for vertical T4/T6 G12 ceramic metal halide lamp. Universal input electronic ballast features end of life shutdown. Fixture is suitable for commercial construction. Insulation must be kept 3" from top and sides of housing. Two stage reflector system produces medium beam distribution with excellent light control and low aperture brightness. Universal housing also accepts lens wall wash.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Housing**

Steel housing encloses optical system protecting reflectors from damage. Tool-less top access allows service from above. Access door allows splice inspection and ballast service through aperture.

**Plaster Frame / Collar**

Die cast aluminum collar accommodates ceiling materials up to 1-1/2" thick.

**Universal Mounting Bracket**

Accepts 1/2" EMT, C channel and bar hangers and adjusts 5" vertically from above the ceiling.

**Junction Box**

(6) 1/2" and (2) 3/4" trade size pry outs positioned to allow straight conduit runs. Listed for (8) #12 AWG (four in, four out) 90°C conductors and feed thru branch wiring.

**Re-lamp**

Suitable for top or bottom lamp replacement.

**Upper Reflector**

Specular clear spun 0.050" thick aluminum produces medium distribution.

**Lower Shielding Reflector**

Spun 0.050" thick aluminum parabolic contour provides 45° lens and lens image cutoff. Self flanged standard with optional white painted flange. Also available with polymer trim ring. Trim ring may be interchanged with metal trim ring available in various finishes or removed for rimless installation, see accessories. Available in all Portfolio Alzak® finishes.

**Shielding**

0.125" thick diffuse glass lens masks arc tube support wire image and color de-mixing common with uncoated ceramic arc sources. Lens is captive during lamp replacement.

**Trim Retention**

Upper and lower reflectors are held securely together and are retained with two torsion springs holding the flange tightly to the finished ceiling surface.

**Socket**

Pulse rated G12 ceramic lamp socket attaches to upper reflector and precisely maintains lamp center.

**Insulation Detector**

Self resetting detector opens circuit if insulation is improperly installed.

**Ballast**

Universal input (except 150 watt) 120/277V electronic ballast provides noise free operation, improved efficiency and increased lamp life as compared with magnetic ballast. Regulated output power over a wide range of ANSI lamp voltages results in excellent color stability over time. End of lamp life shutdown - reset power to restore output.

**Code Compliance**

Thermally protected and cULus listed for protected wet locations. Optional City of Chicago environmental air (CCEA) marking for plenum applications. EMI/RFI emissions per FCC 47CFR part 18 non consumer limits.

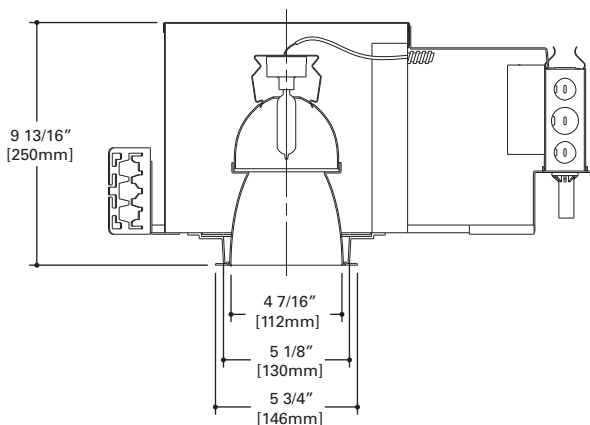


**M420T4G12**  
**M439T6G12**  
**M470T6G12**  
**M4150T6G12**

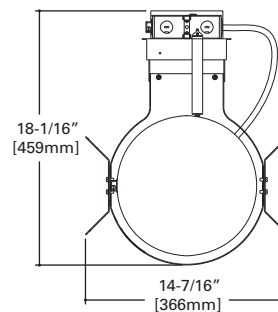
**4950/4951**

**Ceramic Metal Halide**  
**T6 G12**

**4 Inch**  
**Medium Beam Lens Downlight**



**TOP VIEW**



<b>Energy Data</b>	
<b>20W</b>	
120V Input Power: 26W	277V Input Power: 26W
120V Input Current: 0.22A	277V Input Current: 0.11A
Minimum Starting Temp: -15°C, +5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>39W</b>	
120V Input Power: 48W	277V Input Power: 47W
120V Input Current: 0.45A	277V Input Current: 0.18A
Minimum Starting Temp: -20°C, -5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>70W</b>	
120V Input Power: 86W	277V Input Power: 84W
120V Input Current: 0.72A	277V Input Current: 0.31A
Minimum Starting Temp: -20°C, -5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>150W</b>	
120V Input Power: 165W	277V Input Power: 161W
120V Input Current: 1.38A	277V Input Current: 0.59A
Minimum Starting Temp: -30°C, -20°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	





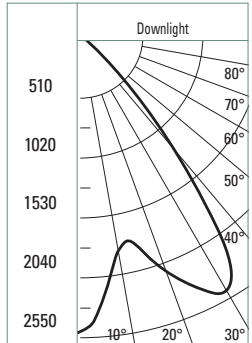
**ORDERING INFORMATION**

**SAMPLE NUMBER: M470T6G12E** = 4" universal housing with UNV 120/277V electronic ballast for a 70W T6 G12 CMH lamp  
**4951LI** = 4" medium beam reflector, self flanged, specular clear low iridescent  
 (Order universal housing and trim separately)

Housing	Lamp Type/Wattage	Ballast	Trim	Finish	Options	Accessories
<p><b>M4</b> = 4" universal CMH housing  <b>M4CP</b> = 4" universal CMH housing, CCEA listed for City of Chicago plenum requirements</p> <p><b>20T4G12</b> = 20W T4 G12 CMH lamp  <b>39T6G12</b> = 39W T6 G12 CMH lamp  <b>70T6G12</b> = 70W T6 G12 CMH lamp  <b>150T6G12</b> = 150W T6 G12 CMH lamp</p> <p>1. Not available with 150 watt                      2. Available with 150 watt only</p>		<p><b>E</b> = Electronic, UNV 120/277V 50/60Hz<sup>1</sup>  <b>1E</b> = Electronic, 120V 50/60Hz<sup>2</sup>  <b>2E</b> = Electronic, 277V 50/60Hz<sup>2</sup></p> <p><b>4950</b> = 4" medium beam reflector, white polymer trim ring  <b>4951</b> = 4" medium beam reflector, self flanged</p>		<p>Alzak® Finishes  <b>LI</b> = Specular clear, low iridescent  <b>H</b> = Semi specular clear  <b>WMH</b> = Warm haze  <b>G</b> = Gold  <b>WH</b> = Wheat  <b>GP</b> = Graphite  <b>GPH</b> = Graphite haze  <b>K</b> = Cognac  <b>KH</b> = Cognac Haze  <b>B</b> = Black</p>	<p><b>WF</b> = White painted flange (self flanged only)</p> <p><b>HB26</b> = Bar hanger, 26" long, pair  <b>HB50</b> = Bar hanger, 50" long, pair  <b>RMB22</b> = Bar hanger for wooden joists, 22" long, pair  <b>HSA4*</b> = Slope adapter for 4" aperture, specify slope  <b>H347</b> = 347V stepdown transformer, 75VA  <b>H347200</b> = 347V stepdown transformer, 200VA</p>	

**PHOTOMETRICS**

**Candlepower Distribution Curve**



Spacing Criteria = 1.1  
Efficiency = 55.3%

Test No. H39130  
M470T6G12E 4950LI  
Lamp = CDM70/T6/830

**Cone of Light**

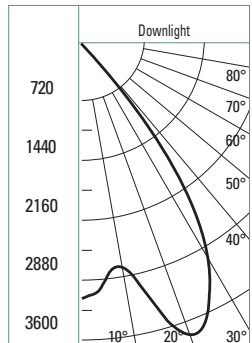
Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'6"	82	6'0"
6'6"	59	7'0"
8'0"	39	9'0"
10'0"	25	11'0"
12'0"	17	13'0"
14'0"	13	15'6"

**Coefficients of Utilization**

Ceiling Wall % RCR	80%				70%				50%		
	70	50	30	10	50	30	10	50	10		
0	66	66	66	66	64	64	64	61	61		
1	62	61	59	58	59	58	57	57	55		
2	59	56	53	51	55	53	51	53	49		
3	55	51	48	46	51	48	45	49	45		
4	52	47	44	41	47	43	41	45	40		
5	49	44	40	37	43	40	37	42	37		
6	46	40	37	34	40	36	34	39	34		
7	43	37	34	31	37	33	31	36	31		
8	41	35	31	28	34	31	28	34	28		
9	38	32	29	26	32	28	26	31	26		
10	36	30	26	24	30	26	24	29	24		

**PHOTOMETRICS**

**Candlepower Distribution Curve**



Spacing Criteria = 1.1  
Efficiency = 30.4%

Test No. H39128  
M4150T6G121E 4950BK  
Lamp = CDM150/T6/830

**Cone of Light**

Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'6"	102	6'0"
6'6"	73	7'0"
8'0"	48	9'0"
10'0"	31	11'0"
12'0"	21	13'0"
14'0"	16	15'6"

**Coefficients of Utilization**

Ceiling Wall % RCR	80%				70%				50%		
	70	50	30	10	50	30	10	50	10		
0	36	36	36	36	35	35	35	34	34		
1	34	34	33	32	33	32	32	32	31		
2	33	31	30	29	31	30	29	30	28		
3	31	29	27	26	29	27	26	28	26		
4	29	27	25	24	27	25	24	26	24		
5	28	25	23	22	25	23	22	24	22		
6	26	24	22	20	23	21	20	23	20		
7	25	22	20	19	22	20	19	21	19		
8	24	21	19	17	20	19	17	20	17		
9	22	19	17	16	19	17	16	19	16		
10	21	18	16	15	18	16	15	18	15		

**DESCRIPTION**

Recessed lens wall wash with 4 inch aperture for T4/T6 G12 ceramic metal halide lamp. Universal input electronic ballast features end of life shutdown. Fixture is suitable for commercial construction. Insulation must be kept 3" from top and sides of housing. Two stage reflector system produces smooth vertical illumination with a minimal downlight component. Universal housing also accepts lens downlight reflector.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Housing**

Steel housing encloses optical system protecting reflectors from damage. Tool-less top access allows service from above. Access door allows splice inspection and ballast service through aperture.

**Plaster Frame / Collar**

Die cast aluminum collar accommodates ceiling materials up to 1-1/2" thick.

**Universal Mounting Bracket**

Accepts 1/2" EMT, C channel and bar hangers and adjusts 5" vertically from above the ceiling.

**Junction Box**

(6) 1/2" and (2) 3/4" trade size pry outs positioned to allow straight conduit runs. Listed for (8) #12 AWG (four in, four out) 90°C conductors and feed thru branch wiring.

**Re-lamp**

Suitable for top or bottom lamp replacement.

**Upper Reflector**

Clear anodized spun 0.050" thick aluminum upper reflector rotates 365° within housing and locks in position with a captive knurl nut.

**Lower Shielding Reflector**

Spread lens combined with a 0.050" thick aluminum angle cut parabolic contour provides smooth vertical illumination with no flashback. Self flanged standard with optional white painted flange. Also available with white painted die cast trim ring. Available in all standard Alzak® finishes.

**Trim Retention**

Retained with two torsion springs holding the flange tightly to the finished ceiling surface and keyed to rotation mechanism to prevent improper orientation.

**Socket**

Pulse rated G12 ceramic lamp socket attaches to upper reflector and precisely maintains lamp center.

**Insulation Detector**

Self resetting detector opens circuit if insulation is improperly installed.

**Ballast**

Universal input (except 150 watt) 120/277V electronic ballast provides noise free operation, improved efficiency and increased lamp life as compared with magnetic ballast. Regulated output power over a wide range of ANSI lamp voltages results in excellent color stability over time. End of lamp life shutdown - reset power to restore output.

**Code Compliance**

Thermally protected and cULus listed for protected wet locations. Optional City of Chicago environmental air (CCEA) marking for plenum applications. EMI/RFI emissions per FCC 47CFR part 18 non consumer limits.

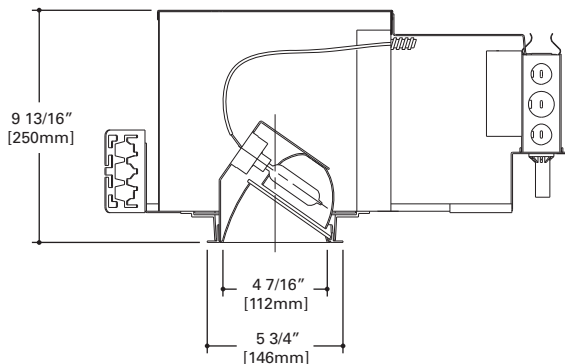


**M420T4G12**  
**M439T6G12**  
**M470T6G12**  
**M4150T6G12**

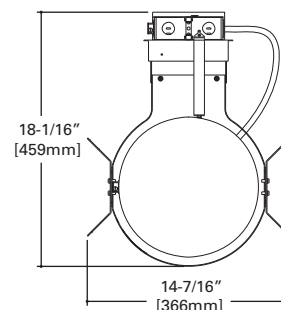
**4981/4983**

**Ceramic Metal Halide**

**4 Inch**  
**Lens Wall Wash**



**TOP VIEW**



<b>Energy Data</b>	
<b>20W</b>	
120V Input Power: 26W	277V Input Power: 26W
120V Input Current: 0.22A	277V Input Current: 0.11A
Minimum Starting Temp: -15°C, +5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>39W</b>	
120V Input Power: 48W	277V Input Power: 47W
120V Input Current: 0.45A	277V Input Current: 0.18A
Minimum Starting Temp: -20°C, -5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>70W</b>	
120V Input Power: 86W	277V Input Power: 84W
120V Input Current: 0.72A	277V Input Current: 0.31A
Minimum Starting Temp: -20°C, -5°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	
<b>150W</b>	
120V Input Power: 165W	277V Input Power: 191W
120V Input Current: 1.38A	277V Input Current: 0.59A
Minimum Starting Temp: -30°C, -20°F	
THD: <20%	Power Factor: >0.90
Sound Rating: A	

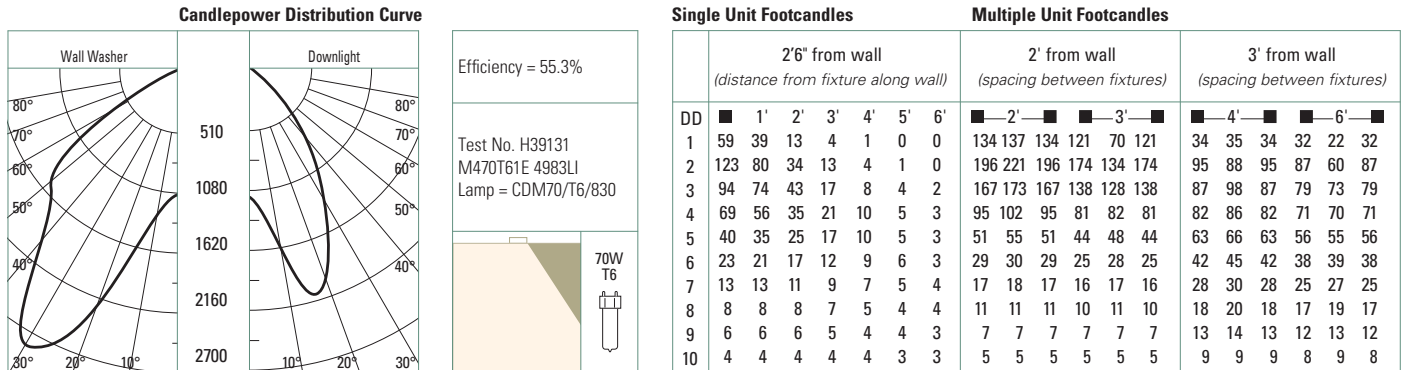
**ORDERING INFORMATION**

**SAMPLE NUMBER: 4981LI** = 4" wall wash reflector, self flanged, specular clear low iridescent (Order universal housing and trim separately)

Housing	Lamp Type/Wattage	Ballast	Trim	Finish	Options	Accessories
<p><b>M4</b> = 4" universal CMH housing</p> <p><b>M4CP</b> = 4" universal CMH housing, CCEA listed for City of Chicago plenum requirements</p>	<p><b>20T4G12</b> = 20W T4 G12 CMH lamp</p> <p><b>39T6G12</b> = 39W T6 G12 CMH lamp</p> <p><b>70T6G12</b> = 70W T6 G12 CMH lamp</p> <p><b>150T6G12</b> = 150W T6 G12 CMH lamp</p>	<p><b>E</b> = Electronic, UNV 120/277V 50/60Hz<sup>1</sup></p> <p><b>1E</b> = Electronic, 120V 50/60Hz<sup>2</sup></p> <p><b>2E</b> = Electronic, 277V 50/60Hz<sup>2</sup></p>	<p><b>4981</b> = 4" lens wall wash, self flanged</p> <p><b>4983</b> = 4" lens wall wash, white painted die cast aluminum trim ring</p>	<p>Alzak® Finishes</p> <p><b>LI</b> = Specular clear, low iridescent</p> <p><b>H</b> = Semi specular clear</p> <p><b>WMH</b> = Warm haze</p> <p><b>G</b> = Gold</p> <p><b>WH</b> = Wheat</p> <p><b>GP</b> = Graphite</p> <p><b>GPH</b> = Graphite haze</p> <p><b>K</b> = Cognac</p> <p><b>KH</b> = Cognac Haze</p> <p><b>B</b> = Black</p>	<p><b>None</b></p>	<p><b>HB26</b> = Bar hanger, 26" long, pair</p> <p><b>HB50</b> = Bar hanger, 50" long, pair</p> <p><b>RMB22</b> = Bar hanger for wooden joists, 22" long, pair</p> <p><b>H347</b> = 347V stepdown transformer, 75VA</p> <p><b>H347200</b> = 347V stepdown transformer, 200VA</p>

1. Not available with 150 watt  
2. Available with 150 watt only

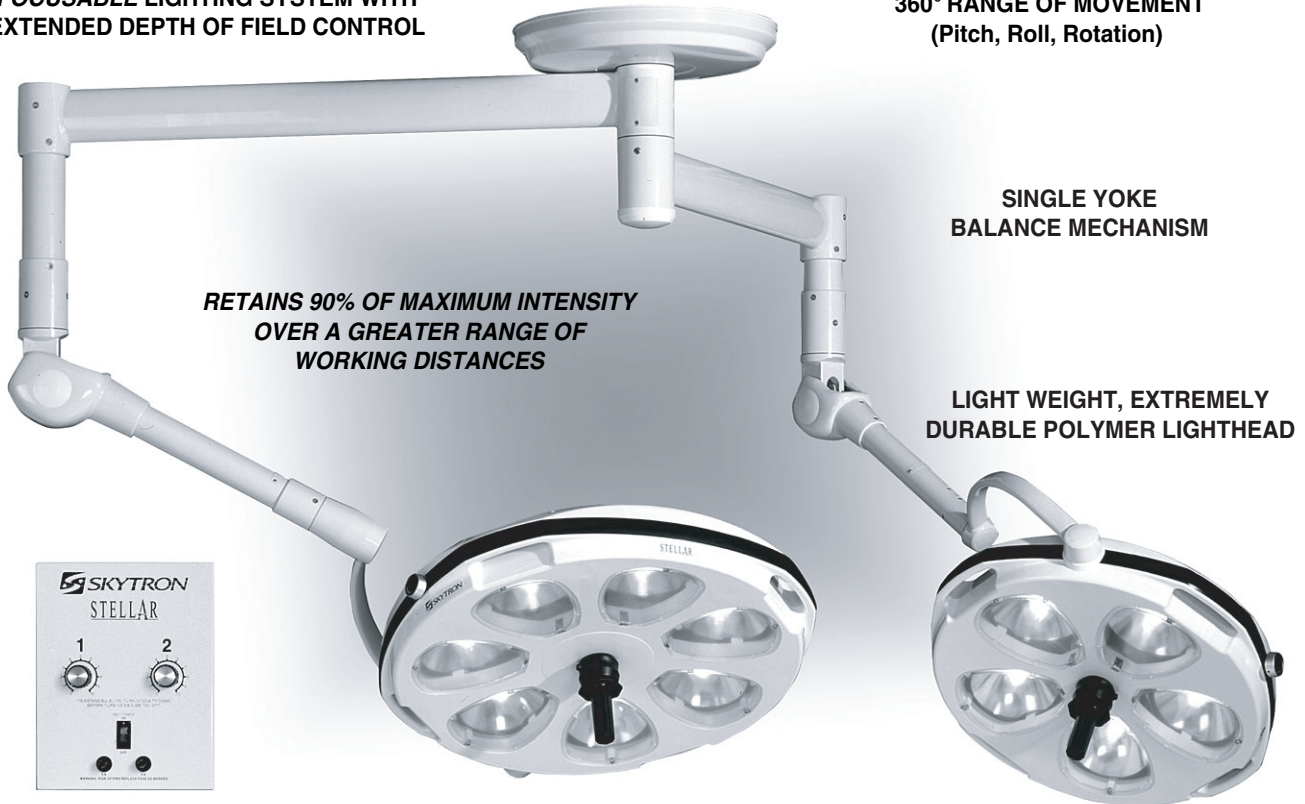
**PHOTOMETRICS**



**STELLAR SERIES • SURGICAL LIGHTS**

**FOCUSABLE LIGHTING SYSTEM WITH EXTENDED DEPTH OF FIELD CONTROL**

**360° RANGE OF MOVEMENT (Pitch, Roll, Rotation)**



**RETAINS 90% OF MAXIMUM INTENSITY OVER A GREATER RANGE OF WORKING DISTANCES**

**SINGLE YOKE BALANCE MECHANISM**

**LIGHT WEIGHT, EXTREMELY DURABLE POLYMER LIGHTHEAD**



**WALL CONTROL WITH EXCLUSIVE SKYTRON SOF-START BULB PROTECTION**

**STERILE POSITIONING/FOCUS CONTROL HANDLE**

**NON-STERILE POSITIONING HANDLES**

**INTRODUCTION**

SKYTRON's Stellar Series Surgical Lighting provides 21<sup>st</sup> Century focusable lighting optics within extremely durable, light weight polymer lighthead, creating the perfect balance between performance, maneuverability and durability. Advanced VSRD Optics (Vertical Segmented Reflector Design) provide precision focus control and shadow free illumination, while retaining 90% of maximum intensity over a greater range of working distances. Typical applications include General, Orthopedic Plastics, Micro Surgery, Cardiovascular, OB/GYN, Trauma and Urology.

**TECHNICAL DATA**

- Electrical:** 120V, 60 Hz, 1 phase
- Power Consumption:** 600 watts (2,040 BTU/hr)
- Amperage:** Approximately 6.0 amps, fuse protected.
- Intensity:** 290,000 lux (27,000 fc)
- Color Temperature:** 4,000K
- Beam Temperature:** Less than 25,000 microwatts per cm<sup>2</sup> as recommended by the I.E.S. handbook.
- Current Leakage:** Less than 30 microamps
- Bulb Type:** Halogen 24V/50W
- Fixture Weight:** 230 lbs.
- Moment Load:** 999 ft. lbs.

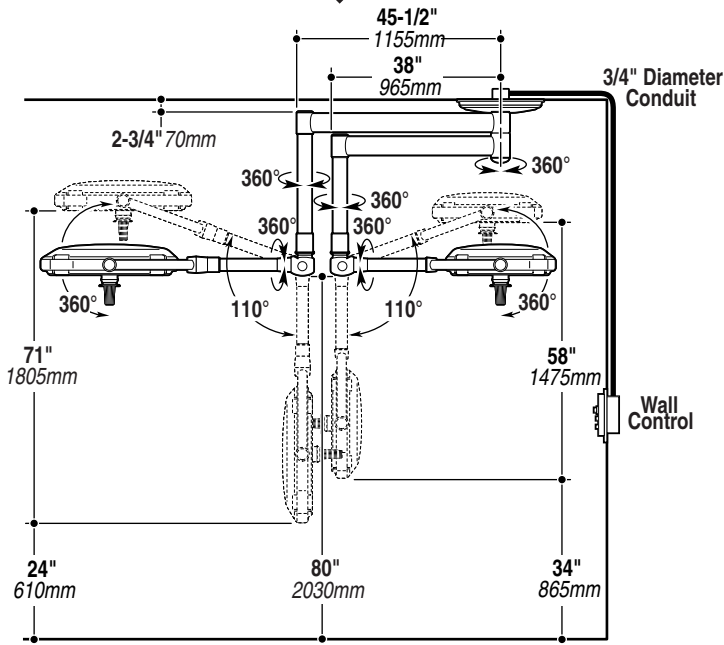
**ACCESSORIES**

- Wall Mounted Intensity Control** provides continuous intensity adjustment according to surgeon's requirements and can be set for high or low line voltage to assure maximum performance. Required, priced separately.
- Camera System** is optional and may be added to camera ready lighting system.
- Voice or Touchscreen** activated remote control systems available as an option.

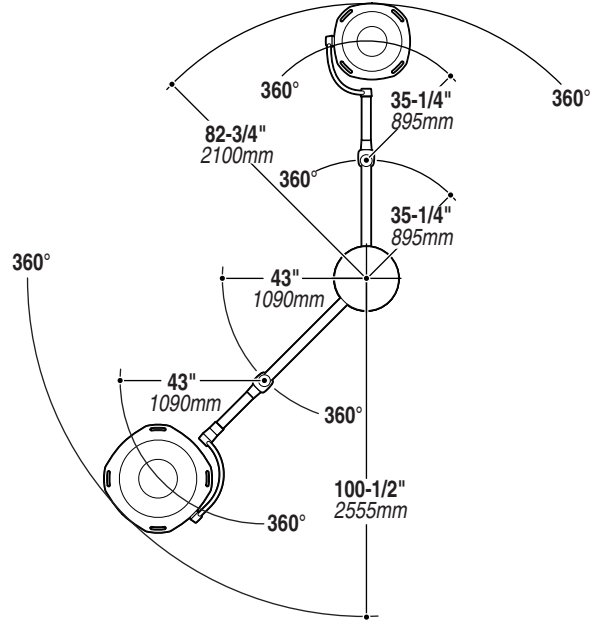
**ARCHITECTURAL SPECIFICATIONS**

Surgical lighting system shall consist of a dual radial arm mounted 29" diameter lighthead with a 23" diameter satellite. Both lighthead are equipped with a sterilizable focus adjustment and positioning handle as well as non-sterile positioning handles and a side focus knob. Total system output is to be 290,000 lux (27,000 foot-candles) at a color temperature of 4,000K. The system is to be designed with 7 bulbs in the 29" diameter lighthead and 5 bulbs in the 23" satellite to eliminate the need to change bulbs during surgery. Bulb life is protected by Skytron's Sof-Start System. Wall Control provides intensity adjustment and ON/OFF control. Bulbs are to be 24V, 50W Halogen type and operate between 18.5 and 20.5 volts. System design is to provide cool, color corrected light that is diffused evenly over the surgical site for optimum shadow reduction. System shall be SKYTRON Model ST2923.

ELEVATION VIEW



PLAN VIEW

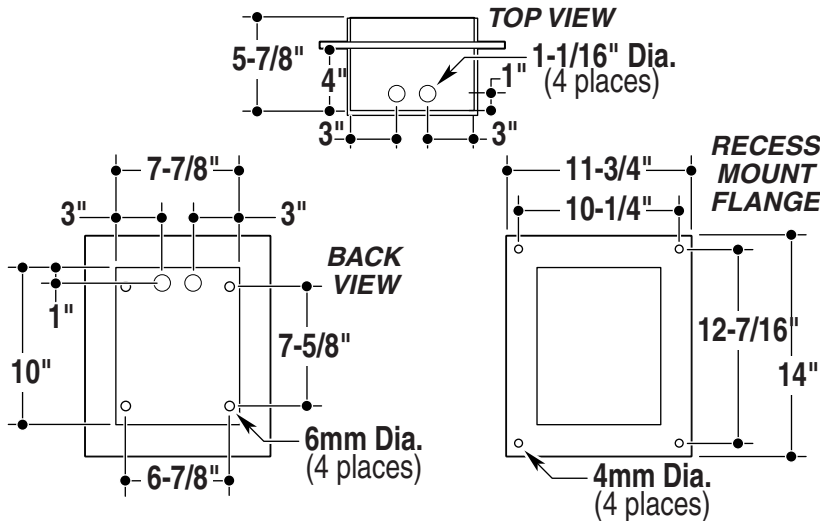


Minimum ceiling height 8'-8". Consult your SKYTRON representative for lower ceiling heights and special applications

REFER TO APPROPRIATE MOUNTING STRUCTURE GUIDELINE

- STANDARD MOUNTING STRUCTURE GUIDELINE
- SPECIFIC SEISMIC CALCULATIONS IF APPLICABLE

WALL CONTROL



**SKYTRON**  
 5085 Corporate Exchange Blvd. S.E.  
 Grand Rapids, MI 49512  
 1.800.SKYTRON • 616.656.2900 • FAX: 616.656.2906

## DESCRIPTION

Halo Raceway Trac provides electrical flexibility at a fraction of the cost of conventional wiring on long linear runs. Fully polarized and grounded throughout. Top portion of track is designed as a raceway. Will carry up to 6 #12AWG conductors. Can be used to feed additional sections of track from the original feed point, minimizing installation time and cost. Raceway covers are included. Halo Raceway Trac accepts both Halo and Lazer-by-Halo lampholders.

Catalog #	Type
Project	<b>T Track</b>
Comments	
Prepared by	Date

## SPECIFICATION FEATURES

### A. Structural

Extruded aluminum .070" [1.8mm] nominal wall thickness. Raceway Trac is only 1 5/16" (33mm) deep by 1 3/8" (35mm) wide.

### B. Ground Conductor

Exclusive independent grounding buss conductor. Maintains an independent positive ground [#12 AWG] path between lampholder, Trac channel and building's ground system.

### C. Neutral Conductor

Solid copper buss bar [cross section equivalent to #12 AWG wire].

### D. Line Conductor

Solid copper buss bar [cross section equivalent to #12 AWG wire].

### E. Insulating Liner

Extruded PVC insulator.

### F. Raceway Capacity for Additional Circuits

Carries up to six #12 AWG conductors. Electrical capacity is 20 AMPS.

### G. Raceway Cover

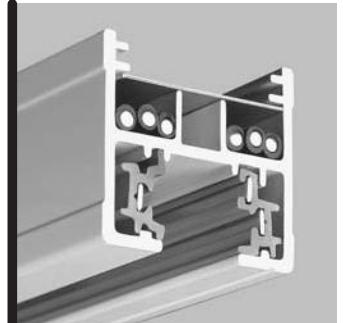
Metal cover.

### H. Polarity Indicator (Neutral)

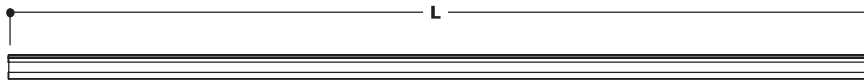
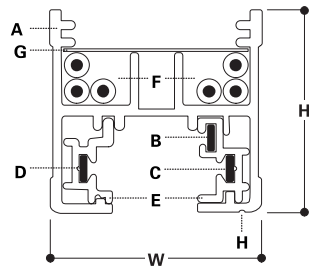
Visual polarity groove indicates proper electrical installation of lampholder adapter.

### Listing

Halo Raceway Trac is UL listed and CSA certified for use with Halo and Lazer-by-Halo lampholders.



**L611, L612, L613**



**RACEWAY  
SINGLE CIRCUIT  
SURFACE MOUNTED  
TRAC SYSTEM**

Power-Trac

## ORDERING INFORMATION

SAMPLE NUMBER: 611MB

Trac	Finishes	Accessories
L611 L612 L613	P=Satin White MB=Matte Black	(See Below)



L611	L612	L613
L = 4': Actual length 44 1/8" [1121mm] W = 1 3/8" [35mm] H = 1 5/16" [33mm]	L = 8': Actual length 98 1/8" [2492mm] W = 1 3/8" [35mm] H = 1 5/16" [33mm]	L = 12': Actual length 140 1/8" [3559mm] W = 1 3/8" [35mm] H = 1 5/16" [33mm]
<b>Color codes</b> P = White MB = Matte Black	<b>Color codes</b> P = White MB = Matte Black	<b>Color codes</b> P = White MB = Matte Black

Connectors	
L900	Outlet Box Cover
L911	Live End Connector
L913	Straight Connector
L914R	L Connector, right hand
L914L	L Connector, left hand
L915R	T Connector, right hand
L915L	T Connector, left hand
L916	X Connector
L981	Conduit Adapter
Accessories	
L984	T-Bar Attachment Clip
L993	Pendant Kit assembly
L48	48" Steel Stem
L994	Pendant Adapter
DE611	Dead End

ADV042194  
Supersedes ADV990395  
9/04  
TAB: Track Systems  
Sheet 9

Note: Specifications and Dimensions subject to change without notice.

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**DESCRIPTION**

Linea's heavy-duty performer features a full yoke and enclosed 35W MR11 or 50W MR16 lamp. Available in white, black and silver finishes. For Halo Linea surface and wireway channel systems. May also be used with Halo and Lazer Track systems with L2004 solid state adapter (12V lamps).

Ideal for accent and dramatic display applications. Use with Linea low voltage lighting systems operated at 12 or 24 volts.

Catalog #	Type
Project	<b>T Heads</b>
Comments	
Prepared by	Date

**SPECIFICATION FEATURES**

**A--Electrical Quick Lock Adapter**

Polycarbonate casing. Attaches electrically and mechanically anywhere along Linea channel.

**B--Arm**

Perforated double-arm yoke allows lampholder to rotate 338° horizontally and provides 0° to 90° vertical pivot for maximum aiming adjustability.

**C--Lampholder Body**

Deep-drawn aluminum housing provides good thermal performance.

**D--Light Baffle**

Deep-drawn baffle restricts light spill and removes for easy lamp replacement. LV308 only - allows use of two filters or lenses.

**E--Cover Glass**

Fixture provided with optional cover glass (required for use with non-open fixture rated lamps).

**Grounding**

Low-voltage lighting systems do not require grounding when used with LV500 series isolated power supplies.

**Labels**

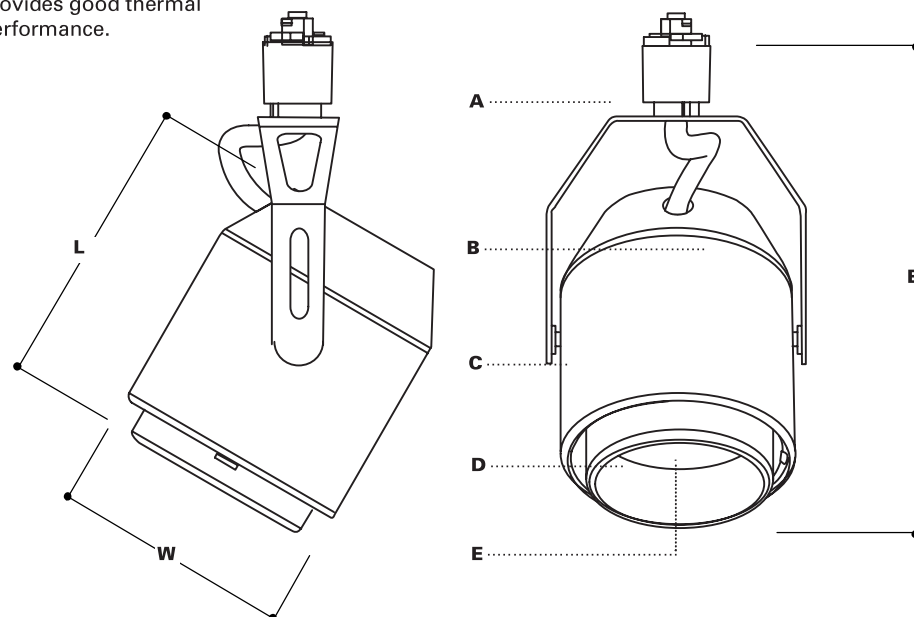
UL listed and CSA certified for use with Linea surface and wireway channel systems.



**LV307**





**LV308**

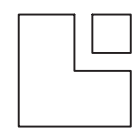


**MINI-ALTO  
LOW VOLTAGE  
LAMP HOLDERS**  
Linea

**ORDERING INFORMATION**

SAMPLE NUMBER: LV307P

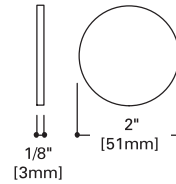
Lampholders	Finishes	Accessories	Lamps
<p>LV307</p> <p>LV308</p> 	<p>P=Satin White</p> <p>MB=Matte Black</p> <p>SL=Silver</p> 	<p>(See Below)</p>	<p>Z84=35W MR11 G4 10° Spot, 24V</p> <p>Z85=35W MR11 G4 30° Flood, 24V</p> <p>Z23=35W MR11 G4 10° Spot, 12V</p> <p>Z24=35W MR11 G4 40° Flood, 12V</p> <p>Z86=35W MR16 G4 12° Spot, 24V</p> <p>Z87=35W MR16 G4 40° Flood, 24V</p> <p>Z88=50W MR16 G4 12° Spot, 24V</p> <p>Z89=50W MR16 G4 40° Flood, 24V</p> <p>Z32=20W MR16 VNSP, 12V</p> <p>Z30=20W MR16 NSP, 12V</p> <p>Z35=20W MR16 FL, 12V</p> <p>Z22=42W MR16 VNSP, 12V</p> <p>Z20=42W MR16 NSP, 12V</p> <p>Z25=42W MR16 NFL, 12V</p> <p>Z21=50W MR16 NSP, 12V</p> <p>Z26=50W MR16 NFL, 12V</p> <p>Z31=50W MR16 FL, 12V</p>
<p><b>LV307</b></p> <p>For use with: 35W MR11</p> <p>L =2 3/4" [38mm]</p> <p>W=2" [38mm]</p> <p>E =4" [73mm]</p>	<p><b>LV308</b></p> <p>For use with: up to 50W MR16</p> <p>L =3 1/8" [79mm]</p> <p>W=2 5/8" [67mm]</p> <p>E =5" [127mm]</p> <p><b>Accessories</b></p> <p>L100 Series color filters, lenses and louver</p>		



**L100 Series 2" 50mm UV and Color Filters**

For use with MR16 Lampholders. Make a powerful lighting statement by injecting soft or intense hues to accent any space.

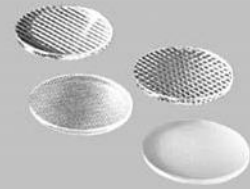
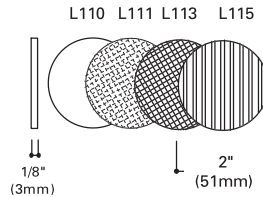
- L112=Red Gel Filter
- L114=Ultraviolet, Dichoric Filter
- L120=Red, Dichoric Filter
- L121=Amber, Dichoric Filter
- L122=Yellow, Dichoric Filter
- L123=Green, Dichoric Filter
- L124=Daylight Blue, Dichoric Filter
- L125=Blue, Dichoric Filter
- L127=Cosmetic (2700°K), Dichoric Filter
- L130=Yellow Gel Filter
- L131=Amber Gel Filter

**L100 Series UV and Color Filters****L100 Series Optical Lenses****L110N=Diffuse Sandblasted Lens**

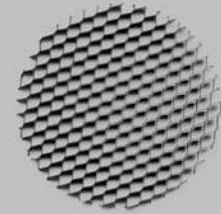
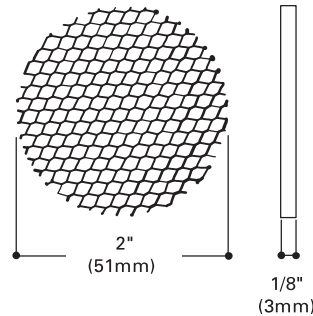
Provides an even beam spread from MR16 lamps—especially useful in wall washing.

**L111=Soft Focus Lens**  
Smooths irregular beam pattern while maintaining high controlled illumination levels and beam angles of MR16 lamps.

- L113=Prismatic Spread Lens**  
Provides a symmetrical broadening of MR16 lamp beams. Suitable when a wide, uniform light distribution is required.
- L115=Linear Spread Lens**  
Fans out the MR16 beam 55° (27 1/2° to each side) to produce a wide rectangular pattern.

**L110 Series Optical Lenses****LV100 Series Louver**

**LV100MB=Expanded metal louver.**  
Miniature black finished hexagonal-cell louver - controls light spill while retaining lamp optics.

**L100 Series Louver**

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)



## DESCRIPTION

Solid-state adapter allows all Linea Lampholders (except) LV301 and LV302 wedge-base lampholders) to be used with Halo and Lazer by Halo line voltage track systems. This device contains electronics that step down the 120V line voltage to 12 volts.

Catalog #	Type
Project	<b>T</b>
Comments	<b>Adapter</b>
Prepared by	Date

## SPECIFICATION FEATURES

### A--Electrical Quick Lock

#### Adapter/Housing

Polycarbonate casing. Attaches electrically and mechanically anywhere along the track. Visual polarity line assures proper orientation. Two position conductor allows use in single circuit and either circuit of two circuit track

### B--Solid-State Electronics

Next generation electronics converts 120 volt line to 12 volts to drive lamp. This device will withstand overloads up to 75 watts continuously and permanent short circuits. The overload and short circuit protection automatically resets after overload or short is removed without cycling input power. Fully dimmable from 1% to 100% with three-wire dimming suitable for dimming solid state power supplies.

### C--Locking Latch

Ribbed locking latch engages track to firmly secure adapter in place.

### D--Linea Lampholder Interface

Interface will only accept Linea lampholder adapters. Other lampholders cannot be inserted in L2004.

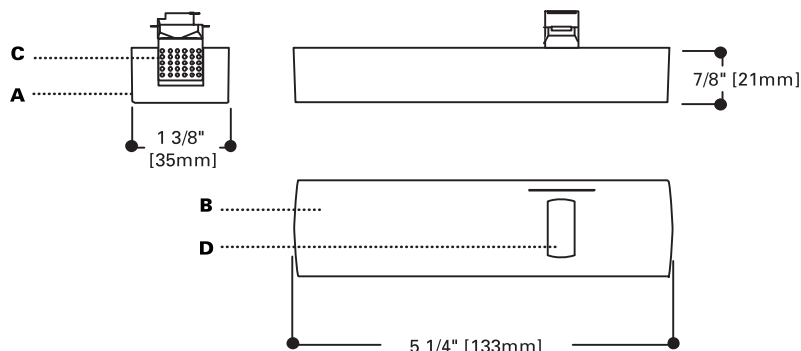
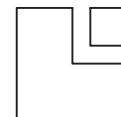
### E--Agency Approvals

UL, CSA, Non-consumer limits FCC Part 18



## L2004

## Solid-State Adapter



## ORDERING INFORMATION

SAMPLE NUMBER: L2004P

### Power Supply

L2004=Solid State Adapter (120V in/12V out)

### Finish

P=White  
MB=Black

### Electrical Data:

THD:	≤ 5%
Power Factor:	>.996
Input Wattage:	51.53
Input Current:	0.4327

ADV020820

9/04

TAB: Linea lampholders and Track  
Sheet 9

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at [www.cooperlighting.com](http://www.cooperlighting.com)

X

MODEL BX

BETALUX®

**NO WIRING  
NO ELECTRICITY  
NO BATTERIES  
NO MAINTENANCE**



**SRB EXIT SIGNS**

**ALWAYS ON .... ALWAYS WORKING**

- *No Wiring*
- *No Electricity*
- *No Batteries*
- *No Maintenance*
- 



**ISO 9001**

**SRB TECHNOLOGIES INC.**

Tel: (336) 659-2610

Fax: (336) 768-7720

Toll Free: 1-800-552-0098

E-Mail: [sales@srbtechnologies.com](mailto:sales@srbtechnologies.com)

Web: [WWW.SRBTECHNOLOGIES.COM](http://WWW.SRBTECHNOLOGIES.COM)



# BETALUX® (BX) FEATURES

- VANDAL RESISTANT
- OPERATING TEMPERATURE - 76°F TO +212°F
- EXPLOSION PROOF
- WATERPROOF
- REQUIRES NO WIRING
- FIELD SELECTABLE DIRECTION ARROWS
- INSTALLS IN MINUTES
- SUITABLE FOR CLEAN ROOM APPLICATIONS
- NO BULB TO FAIL OR REPLACE
- CORROSION RESISTANT
- FAIL SAFE
- RECYCLABLE IF RETURNED TO MANUFACTURER
- LIGHTWEIGHT
- 10, 15 OR 20 YEAR LIFE
- TOTALLY SELF POWERED

# TYPICAL APPLICATIONS



\* NO ELECTRICITY

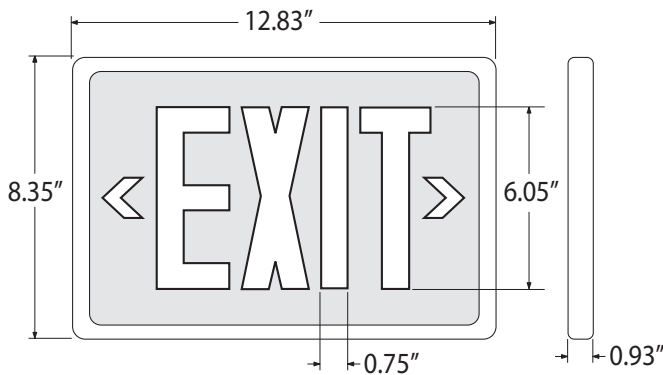
\* NO BATTERIES

\* ALWAYS ON

\* SELF-POWERED

\* NO MAINTENANCE

# SPECIFICATIONS



### ILLUMINATION SOURCE

- Borosilicate (hard) glass
- Internally coated with phosphorescent powder
- Filled with Tritium gas

### BRIGHTNESS

- Minimum brightness at time of manufacture of 0.15 foot lamberts.

### CONSTRUCTION

- Encased in high-impact, fire-retardant ABS plastic

### COMPLIES WITH:

- NFPA Life Safety Code 101
- U.L. 924
- City of Los Angeles
- State of California
- Council of American Building Officials (ICBO, SBCCI)
- OSHA
- USNRC
- ISO 9001

\* NO ELECTRICITY

\* NO BATTERIES

\* ALWAYS ON

\* SELF-POWERED

\* NO MAINTENANCE

# ORDERING INFORMATION

MODEL	LIFE IN YEARS	FRAME COLOUR	FACES	LEGEND COLOUR	ACCESSORIES
BX	10 - 10 Years	GY - Gray	S - Single	RD - Red	WG - Wire Guard
	15 - 15 Years	BK - Black	D - Double	GN - Green	AF - Aluminum Frame
	20 - 20 Years	WH - White			PC - Polycarbonate Window
					PM - Pendant Mount
					SC - Security Cover

ORDERING EXAMPLE: BX-10-BK-S-RD = BX, 10 Year, Black Frame, Single Face Sign with Red Legend

# COOPER LIGHTING - SURE-LITES®

## DESCRIPTION

The Sure-Lites ES Series Exits are designed for architectural excellence and minimal presence. The crystal clear wedge shaped panel allows architectural details to shine through while providing excellent light distribution and exit visibility. Long life, energy efficient LED lamps reduce energy costs and eliminate routine lamp maintenance.

Catalog #		Type
Project		XH
Comments		Date
Prepared by		

## SPECIFICATION FEATURES

### Electronics

- Dual Voltage Input, 120/277 VAC 60Hz
- Long-life energy efficient LED lamps
- Solid-state Voltage Charger
- Solid-state Switching
- Brownout Circuit
- Test Switch/Power Indicator Light

### Battery

- Sealed Nickel Cadmium
- Maintenance-Free, Long-Life
- Full Recharge Time, 24 hrs. (max.)

### Housing Construction

- 18-gauge steel housing with conduit knockouts
- Recessed housing available for ceiling or wall mounting
- Adjustable hanger bars
- Connectors facilitate quick installation and maintenance
- Convenient 1/2" knockouts provided in top and end of surface mounted housing

### Trim/Housing Plate

- Injection molded high-impact acrylic panel
- NFPA 101 compliant chevron directional indicators (when specified)
- Extruded trim plate in Brushed or Polished Aluminum, Polished

- Brass, White, Black and Bronze
- Red and Deep Green letter colors
- 6" Letters
- Clear, mirror, or white background
- Torsion springs secure trim plate to housing - no visible mounting hardware

### Lamp Data

- LED, Red: Super-bright, long-life LEDs provide uniform illumination

### Warranty

- Exit: 1-year
- Battery: 15-year pro-rata (self-powered only)



**ES  
SERIES**

AC  
SELF POWERED

SURFACE OR RECESSED

EDGELIT EXITS

LED LAMPS

EXIT LIGHTING

TOTALLY PREDICTABLE  
**RELIABILITY**

## ORDERING INFORMATION

<b>Series</b> ES6=AC Only, LED Lamps ES7=Self-Powered, LED Lamps ESH6=Housing For ES Recessed AC Only ESH7=Housing For ES Recessed Self-Powered EST6: Trim And Panel For ES Series Recessed AC Only EST7: Trim And Panel For ES Series Recessed Self-Powered	<b>Face Options</b> 1=Single 2=Double  <b>Battery</b> _ = No Battery 70= Nickel Cadmium  <b>Mounting</b> _ = Recessed Unit S: Surface Unit	<b>Trim Finish</b> _ = Brushed Aluminum WH=White BL=Black BZ=Bronze PS=Polished Brass PA= Polished Aluminum	<b>Letters / Background</b> R=Red / Clear (Single Face Only) G=Green / Clear RM=Red / Mirror GM=Green / Mirror RW= Red / White  <b>Chevron Direction</b> _ = No Chevron AR: Right Chevron AL: Left Chevron DA: Double Chevron ARL: Chevrons Right / Left (Double Face Only)	<b>Voltage</b> _ = 120 / 277V  <b>Mounting Options</b> C=Ceiling W=Wall E= End P= Pendant
--	--	---	---	--

### ENERGY DATA

Maximum power consumption under all charge conditions:

#### LED Exits, Red Letters, AC Only

Input Power:  
120V = 3.8W  
277V = 3.9W  
Input Current (Max.):  
120V = .03  
277V = .02  
Power Factor:  
120V = .93  
277V = .93

#### LED Exits, Red Letters, Self-Powered

Input Power:  
120V = 4.6W  
277V = 4.8W  
Input Current (Max.):  
120V = .04  
277V = .02  
Power Factor:  
120V = .90  
277V = .89

### ENERGY DATA

#### LED Exits, Green Letters, AC Only

Input Power:  
120V = 1.4W  
277V = 1.5W  
Input Current (Max.):  
120V = .02  
277V = .01  
Power Factor:  
120V = .67  
277V = .66

#### LED Exits, Green Letters, Self-Powered

Input Power:  
120V = 1.9W  
277V = 2.0W  
Input Current (Max.):  
120V = .03  
277V = .01  
Power Factor:  
120V = .63  
277V = .61

TECHNICAL DATA

**Lamp**

Optimized for energy efficiency and aesthetic appearance, the ES Series Exit uses superbright, long-life LED lamps to illuminate the exit lens.

**Power Housing (Self-Powered Only)**

Dual voltage 120/277 VAC power housing is contained in the rough-in section. It will automatically illuminate the sign face for 90 minutes during a power interruption. Power housing is equipped with maintenance-free sealed nickel cadmium batteries.

**Electrical**

The electronics with quick connect connectors and simple wiring combine to make installation of the ES Series Exit fast and easy. Self-Powered and AC versions are standard 120/277 VAC. If necessary, ES Series housings and trim assemblies can be shipped separately for rough-in situations.

**Housing Construction**

The rugged 18-gauge, die formed steel housing has conduit knockouts for easy AC wiring connections. Fully adjustable, captive bar hangers make installation easy.

**Trim**

The high-impact, clear acrylic lens panel with precision molded lettering and NFPA 101 compliant directional chevrons makes the face panel of this exit sign clearly superior. A choice of red or deep green letters in clear, mirror, or

white background inserts (deep green available in clear or mirror only) enables precise control of the fixture's aesthetic appearance. The rugged extruded trim plate is attached to the housing back box with torsion springs to insure a tight fit against any wall or ceiling surface. The standard brushed aluminum finish blends with most any decor. Other finishes are available.

**Solid-State Charger (Self-Powered Only)**

Supplied with a 120/277 VAC, voltage regulated solid-state charger. Immediately upon restoration of AC current after a power failure, the charger provides a high charge rate. Solid-state circuitry recharges the battery following a power failure in accordance with UL 924.

**Brownout Circuit (Self-Powered Only)**

The brownout circuit on Sure-Lites' exits monitors the flow of AC current to the exit and activates the emergency lighting system when a predetermined reduction of AC power occurs. This dip in voltage will cause most ballasted fixtures to extinguish causing loss of normal lighting even though a total power failure has not occurred.

**Solid-State Transfer (Self-Powered Only)**

The ES Series Exit incorporates solid-state switching which eliminates corroded and pitted contacts or mechanical failures associated with relays. The switching circuit is designed to

detect a loss of AC voltage and automatically energizes the LED lamps. Upon restoration of AC power, the emergency circuit will switch off and the charger will automatically recharge the battery.

**Test Switch/Power Indicator Light (Self-Powered Only)**

Conveniently located combination Test Switch/Power Indicator Light allows for manual verification of proper operation of the transfer circuit and emergency lamps.

**Sealed Nickel Cadmium Battery (Self-Powered Only)**

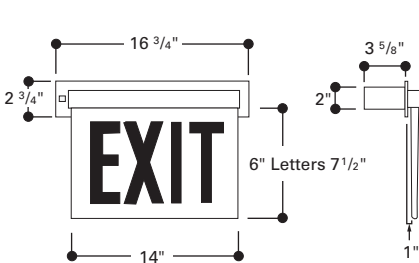
Sure-Lites sealed nickel cadmium batteries are maintenance-free with a life expectancy of 15 years. The sealed rechargeable nickel cadmium battery offers high discharge rates and stable performance over a wide range of temperatures.

**Warranty**

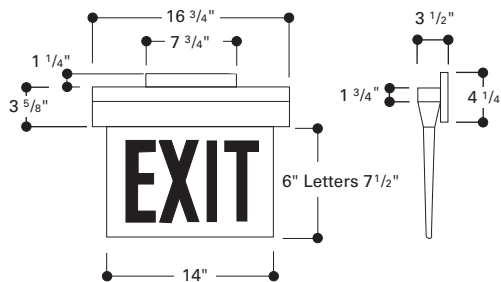
All Sure-Lites' products are backed by a firm one-year warranty against defects in material and workmanship. Maintenance-free, long-life, sealed nickel cadmium batteries carry a fifteen-year pro-rata warranty.

MOUNTING OPTIONS

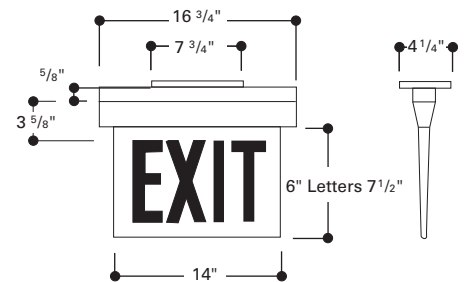
RECESSED, WALL MOUNT



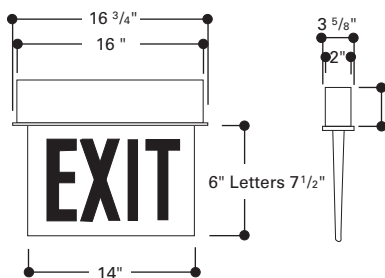
SURFACE, WALL MOUNT



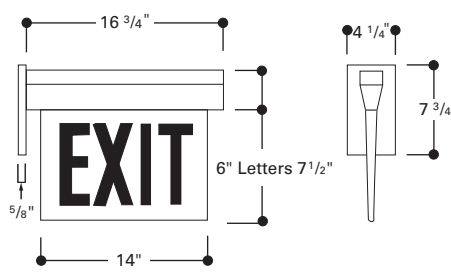
SURFACE, CEILING MOUNT



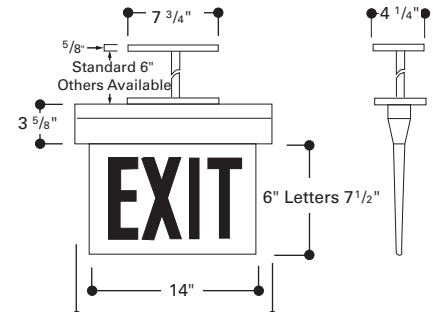
RECESSED, CEILING MOUNT



SURFACE, END MOUNT



SURFACE, PENDANT MOUNT



# CON-X

## Con-X Recessed Exit Signs

The Con-X Recessed Exit Signs provide Architects and Designers with a recessed sign for low profile applications that will complement most interiors. The picture frame design allows the fixture to be mounted flat against a wall. Utilizing a unique cavity illuminated interior, Con-X signs have a bright and uniform illumination throughout the sign. Con-X signs are available in a variety of finishes and custom colors to match interior applications.

### FEATURES

- Recessed design for low-profile applications
- Cavity illuminated design provides uniform illumination
- Low energy consumption
- Long-life LED lamps
- Easy installation



### Product Specification

The exit signs shall be Concealite Con-X Recessed series and will conform to all standards listed in the NFPA Life Safety Code and be installed in accordance to Article 700 of the National Electrical Code. Sign shall be constructed of extruded aluminum and welded for strength. The stencil faces are made of heavy gauge steel (aluminum optional) with knockout chevron arrows that conform to the 1999 UL standard. All electronics shall be solid-state in design and emergency power shall be from a NiCad battery. Illumination shall be by a row of high output LED's located at the top of the sign. Sign shall be a recessed wall mount. The sign shall be listed with a recognized listing laboratory.

CON-X RECESSED



# CON-X RECESSED

XL

## Construction

The signs are constructed of extruded aluminum and welded for strength. The stencil faces are of heavy gauge steel (aluminum optional).

## Installation

Signs measure less than 2" in depth for easy installation in walls. The back plate has a universal knockout pattern for mounting to shallow electrical boxes.

## Finish

Sign frames and stencils are finished with a heavy, chip resistant, powder-coated paint in high gloss white or matte black standard. Custom colors and finishes are available.

## Illumination

Signs are illuminated using high output LED's mounted at the top of the custom cavity producing uniform distribution of light across each letter and arrow. The diffuser is a high grade, unbreakable polycarbonate, silk-screened to enhance the illumination. Models are available in both red and green letters.

## Self-Powered Operation

During normal operation, the LED module provides illumination from standard utility power. When a power failure occurs, a solid-state switch connects a battery to the LED module to provide continuous operation for a minimum of 90 minutes. When AC is restored, the battery returns to charge mode.

## AC Input

Con-X signs have a 120/277 volt universal transformer; a polarized harness assembly is used to connect AC power to the printed circuit board.

## Warranty

Con-X signs are warranted for seven years and the battery carries a seven-year pro-rated warranty.

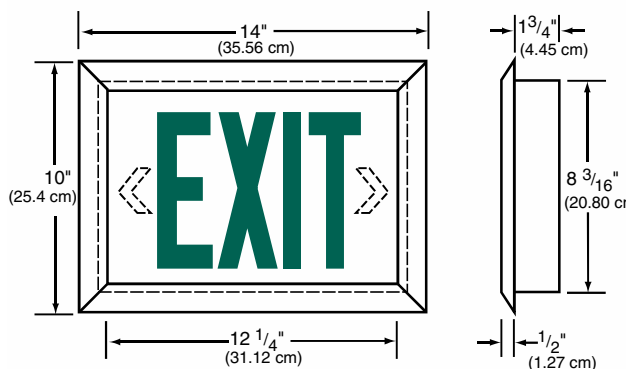
## Con-X Recessed:

Model	Letters	Description	Finish
CR-RW	Red	AC Single Face	White
CR-RB	Red	AC Single Face	Black
CR-RWPP	Red	AC/DC Single Face	White
CR-RBPP	Red	AC/DC Single Face	Black

## Options:

 add suffix to model number

DC	Dual Circuit
F	Flasher
AF	Audible Flasher Module
SW	Special Wording
CC	Custom Color (Lettering)
CF	Custom Finish
G	Green Letters



Note: These specifications are subject to change.



A Division of Gow Industries  
202 Elk Street  
P.O. Box 160  
Elkton, SD 57026  
Phone: (605)542-4444  
Fax: (605)542-3333  
<http://www.concealite.com>  
e-mail: [info@concealite.com](mailto:info@concealite.com)

# COOPER LIGHTING - SURE-LITES®

## DESCRIPTION

The Sure-Lites UX Nema 4X Exit combines the strength and durability of die cast aluminum with architecturally pleasing aesthetics. Designed for the most severe environments, the UX exit will provide maximum performance against rain, moisture, cold, corrosives and dust. Additional designed in features such as LED technology provides the customer with a long-life, low maintenance, dependable exit sign in those conditions when reliability is crucial. The injection molded, clear, polycarbonate provides protection against vandalism. The UX Exit is approved for ambient environments rated from -45C (-49F) up to +60C (+140F).

Catalog #		Type	XWL
Project		Date	
Comments			
Prepared by			

## SPECIFICATION FEATURES

### Electrical

- Dual Voltage Input 120/277 VAC, 60 Hz, Isolation Transformer
- Push-in AC power connectors facilitate installation

### Housing Construction

- Die cast aluminum housing
- Die cast canopy included (for mounting convenience only - no electrical components in canopy)
- Universal pattern knockouts on rear of single face housing for direct mounting to junction box
- Exit can be universally mounted ceiling, wall or end
- Pendant Mount
- Powder coat paint finish
- NFPA 101 compliant knockout chevrons allow quick conversion to directional signs

- UV stable clear, polycarbonate, vandal resistant shield with Torx® head tamperproof screws, stainless steel
- Knockouts provided for 1/2" conduit entry - Exit back plate can be removed and exit converted to double face exit
- T-Code=T5 (HAZ only)

### Lamp Data

- LED lamp provides uniform light output
- Red or green lettering only
- Extremely economical lamp operation

### Code Compliance

- UL 924 Listed
- UL 924, Wet Location Listed (suitable for wet and damp locations)
- UL50, NEMA 4X

- UL844, Hazardous Locations (Class 1, Division 2, Groups A, B, C, D) with "HAZ" option
- Life Safety NFPA 101
- NEC/OSHA
- UL FTBR Listed when specified with the "2C" option
- Most State and Local Codes
- Suitable for Floor Proximity Installation, UL Listed, ADA (American Disabilities Act)
- NSF, National Sanitation Foundation / Splash Zone (for Food Processing)
- IP66, Ingress Protection from IEC (International Electrical Commission)
- Cleanrooms Class 10,000
- Patents Pending

### Warranty

- Exit: 5-year

### Temperature Performance Data

- UX Series Exit Sign:
  - -45°C (-49°F) to 60°C (140°F)
- UX-HAZ Hazardous Location Exit Sign:
  - T6 rating at 45°C (113°F)
  - T5 rating at 60°C (140°F)



## UX SERIES

ULTIMATE EXIT

NEMA 4X

OPTL: CLASS 1 DIV 2  
HAZARDOUS LOCATIONS

PENDANT AND SURFACE  
MOUNT

AC ONLY

LED LAMPS

VANDAL PROOF  
PATENTS PENDING

EXIT LIGHTING



### ENERGY DATA

#### LED Exits - Red

Input Power:  
120V = 2.7W  
277V = 3.2W

Input Current (Max.):  
120V = .07A  
277V = .04A

Power Factor:  
120V = >.30  
277V = >.39

T.H.D.:  
120V = <56%  
277V = <69%

#### LED Exits - Green

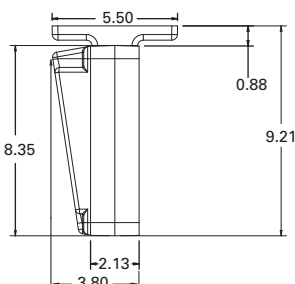
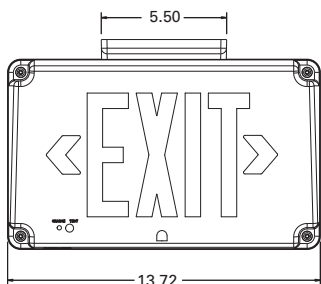
Input Power:  
120V = 2.3W  
277V = 3.0W

Input Current (Max.):  
120V = .08A  
277V = .03A

Power Factor:  
120V = >.26  
277V = >.36

T.H.D.:  
120V = <54%  
277V = <67%

TOTALLY PREDICTABLE  
**RELIABILITY.**



## ORDERING INFORMATION

<b>Series</b> UX6=Nema 4X Exit, AC Only, LED	<b>Factory Options</b> 95=AC Only Fire Alarm Interface	<b>Housing Finish</b> S: Silver WH: White BK: Black	<b>Accessories 2</b> UXUK=Converts Single Face to Double Face Exit. Contains (1) Red Lens, (1) Green Lens, (1) Standard Silver Exit Stencil, (1) Vandal Shield w/Tamperproof Screws UXUKWH= Converts Single Face to Double Face Exit. Contains (1) Red Lens, (1) Green Lens, (1) White Exit Stencil, (1) Vandal Shield w/Tamperproof Screws UXUKBK= Converts Single Face to Double Face Exit. Contains (1) Red Lens, (1) Green Lens, (1) Black Exit Stencil, (1) Vandal Shield w/Tamperproof Screws UXPKA: Pendant Adapter Kit (fitting adapts exit to 1/2" NPT threaded pendant-supplied by others) VRSD: Vandal Resistant Screwdriver
<b>Face Options</b> 0= Universal <sup>1</sup> 1= Single	<b>Letter Colors</b> R: Red G: Green	<b>Options</b> 2C= Two Circuit Operation HAZ= Hazardous Location (Class 1, Division 2, Groups A,B,C,D)	

Notes: 1 Contains one single face exit and one UXUK.  
2 Order separately.



**TECHNICAL DATA**

**Lamps**

The UX Family with energy saving LED lamps offers extremely long-life with very low input wattage. LED lamps are available in either red or green. LED lamps have a long life, eliminating the need for any lamp maintenance under normal conditions.

**Housing**

Die cast aluminum with silver painted finish. NFPA 101 compliant knockout chevrons for easy conversion to directional sign. Universal pattern knockouts are in the back of the single face housing for direct mounting to junction box. Conduit entry knockouts provided. UV stable, polycarbonate shield for protection. Gasketing provides water-tight, dust-tight NEMA 4X enclosure.

**Canopy**

Die cast aluminum alloy canopy included for universal mounting. Canopy is included for mounting convenience only—no electrical components in canopy.

**Electronics**

Dual voltage input 120/277 VAC is standard. All electrical components are enclosed within the exit housing, preserving the low profile appearance.

**"2C" Option**

The UX Series Exit's "2C" Option enables the UX Exit to operate per the requirements of UL 924 when connected simultaneously to both normal and emergency power circuits (two circuit operation—UL Category FTBR – Emergency Lighting and Power Equipment). The

"2C" Option is a factory assembly change which alters the standard UX Series Exit such that it complies with and is UL Listed under the FTBR Category. This option should only be used for exits which are intended to be connected simultaneously to normal and emergency power circuits. Both circuits have universal 120/277 VAC standard.

**Warranty**

The Sure-Lites UX Exit is backed by a firm (5) year warranty against defects in material and workmanship.

**NATIONAL ELECTRICAL CODE (NEC)**

The National Electrical Code (NEC) defines a hazardous location as "a location where fire hazards or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust or ignitable fibers or filings.

The Code further separates these hazardous locations into three classes:

- Class I – locations containing gases and vapors
- Class II – locations containing dust
- Class III – locations containing fibers and filings.

Each of these classes is broken into divisions. These divisions are separated into groups according to characteristics. The UXHAZ Exit Sign Series is rated for Class 1, Division 2, Groups A, B, C, D only.

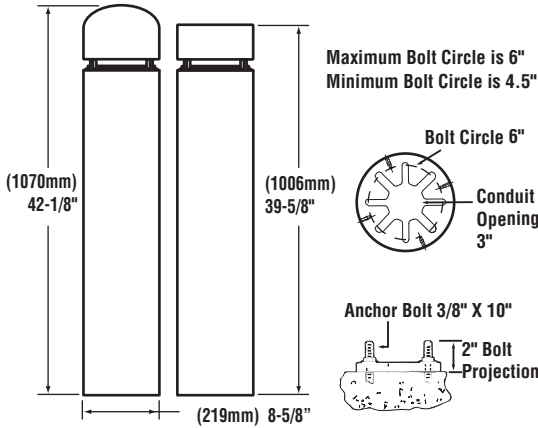
The following chart summarizes these classifications:

Class	Division	Group
I	Gas	2 Potential Exists – May be present in atmosphere
		<b>A</b> Acetylene <b>B</b> Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value less than or equal to 0.45 mm or a minimum igniting current ratio (MIC ratio) less than or equal to 0.40. (Example material is hydrogen) <b>C</b> Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.45 mm and less than or equal to 0.75 mm, or a minimum igniting current ratio (MIC ratio) greater than 0.40 and less than or equal to 0.80. (Example material is ethylene) <b>D</b> Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value greater than 0.75 mm or a minimum igniting current ratio (MIC ratio) greater than 0.80. (Example material is propane)

# LSI GREENLEE HYPERION SERIES



## DIMENSIONS



**LAMP TYPE:** Standard or Ceramic Metal Halide

**HOUSING:** One-piece, heavy-walled, extruded aluminum, .322" thick for vandal resistance.

**CROWN ASSEMBLY:** Flat or domed, heavy cast aluminum. For added security against vandals, crown attaches to lower housing with four captive, concealed 1/4" x 20 Allen-head screws.

**LENS:** One-piece, heavy-walled borosilicate lens is recessed .764" and protected by three cast ribs for vandal resistance. Exposed portion of the lens is only .671" tall.

**OPTICS:** Patented OptX™ optical assembly uses Constructive Occlusion® technology. A precisely positioned clear lamp in a Cavity and Fan™ assembly projects radiant energy into selective zones. Proprietary coating on the cavity is 96% reflective.

**BALLAST:** High Power Factor, multi-tap ballast designed for -20°F operation is standard. Universal electronic ballast for 120-277V, 50 or 60 HZ operation is available.

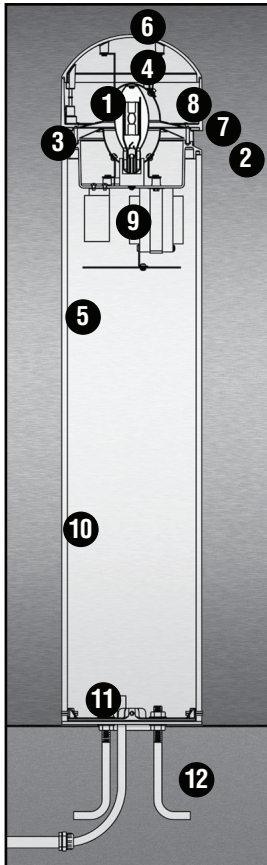
**LAMPHOLDER:** Matched to lamp. Glazed porcelain, medium base, 4KV pulse rated with spring center contact.

**ANCHOR BOLTS:** Anchor bolts are 3/8" x 10" heavy-duty galvanized steel. Four (4) are furnished.

**FINISH:** Each fixture is finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling, and is guaranteed for five full years. Standard colors include bronze, black, platinum plus, white, graphite, satin verde green, and metallic silver.

### EXTRA VALUE FEATURES:

- Unique OptX™ optical assembly
- Tailored, uniform distribution over greater distances.
- Increased spacing between luminaires
- Vandal Resistant Aperture
- Heavy Duty Construction
- Premium Materials



**Bollards are subjected to extreme environments – from severe weather to pedestrian wear-and-tear, and senseless vandalism. The Hyperion Bollard Series was designed with this harsh reality in mind, and that's why its materials are of the highest quality, ruggedly durable, and feature superior vandal resistant construction.**

- 1 OPTICS** – OptX optics are the heart of this luminaire. A clear lamp is precisely positioned in a highly engineered, and patented, Cavity and Fan assembly that functions like an integrating sphere. Known as Constructive Occlusion technology, this sphere uses a proprietary internal coating that realizes 96% reflectance. The lamp's radiant energy is distributed by this finely tuned, reflective surface to desired zones.
- 2 VANDAL RESISTANT APERTURE** – Hyperion features the narrowest aperture of any bollard on the market, a mere 1.167" wide, which gives the luminaire a sleek and elegant appearance while minimizing the target area available to vandals.
- 3 VANDAL RESISTANT LENS** – The one-piece, heavy-walled borosilicate lens is recessed a full .764" and protected by three cast ribs. The exposed portion of the lens is only .671" tall. These design features and premium materials provide superior vandal resistance.
- 4 LAMPS** – Standard and Ceramic Metal Halide
- 5 HEAVY-WALL HOUSING** – One-piece, heavy-wall extruded aluminum, .322" thick for vandal resistance.
- 6 CROWN** – Flat or domed heavy-wall cast aluminum. One-piece castings provide for greater impact strength.
- 7 CONCEALED ACCESS** – Added security against vandals, crown attaches to lower housing with four captive, concealed 1/4" x 20 Allen-head screws.
- 8 SEALING AND GASKETS** – Silicone gaskets and seals ensure Hyperion is as dependable as it is rugged.
- 9 BALLASTS** – Standard ballast is high power factor, designed for -20° operation. Universal electronic ballast available.
- 10 FINISHES** – Metallic Silver, Satin Verde Green, Black, Bronze, White, Buff, Graphite or Platinum Plus polyester powder coating.
- 11 MOUNTING BASE** – Extra thick, 1/2" cast aluminum /magnesium (chromate converted and powder coat finished in black standard). Base is corrosion resistant.
- 12 ANCHOR BOLTS** – 3/8" x 10" heavy-duty galvanized steel; four (4) furnished.

# LSI GREENLEE HYPERION SERIES

## LUMINAIRE ORDERING INFORMATION



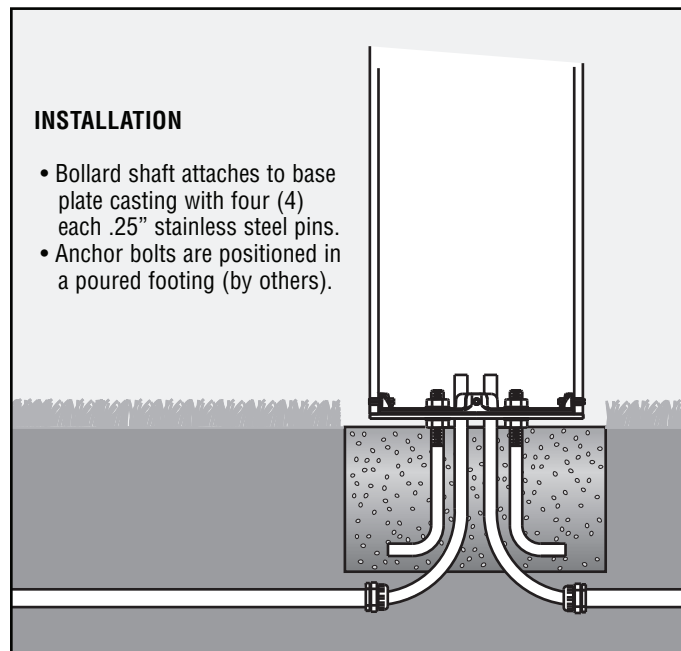
TYPICAL ORDER EXAMPLE: **HYPR 100MH MT OPTX MSV FT H42 PC120**

Luminaire Prefix	Wattage/Lamp Type <sup>1</sup>	Line Voltage	Optics	Luminaire Finish	Top	Height <sup>3</sup>	Options
HYPR	50, 70, 100 CMH/Med E-17 Medium Base Metal Halide Ceramic Arc Tube  39, 70 CMH/T6 T-6 Ceramic Metal Halide with G12 Bi-pin base	480 <sup>2</sup>  MT – Multi Tap TT – Tri-Tap  UE - Universal Electronic (120-277V 50/60Hz)  347 (60Hz)  <b>Consult Factory for International Voltages</b>	OptX <sup>®</sup>	BRZ – Bronze BLK – Black PLP – Platinum Plus BUF – Buff WHT – White SVG - Satin Verde Green GPT - Graphite MSV - Metallic Silver	FT – Flat Top DT – Dome Top	H42	PC120 – 120 Volt Photocell PCHV – 208- 277V Photocell PC347 – 347V Photocell GFR – Ground-Fault Receptacle LPC - BLK Lens Protector casting painted black LL - Less Lamp LAB - Less Anchor Bolts  <b>Accessories</b>  HSS - House Side Shield <sup>4</sup>
<p><b>MT – Multi Tap</b> consists of 120V, 208V, 240V and 277V and is prepared for highest voltage. Alternate voltages will require field adjustment.  <b>TT – Tri-Tap</b> consists of 120V, 277V and 347V and is shipped standard for Canadian applications and is prepared for highest voltage. Alternate voltages will require field adjustment.</p>							

**FOOTNOTES:**

1. All Hyperion Bollards are shipped with lamps installed and 38" leads to facilitate wiring.
2. 480 volt Magnetic Ballast is available for 70 and 100 Watt Metal Halide only.
3. Nominal standard height if 42". Non-Standard heights are available in 6" increments. Minimum height is 18"
4. House Side Shield provides 180° shielding. Maximum fixture rating with HSS is 70 watts. HSS is NOT available for 100 watt fixtures.

### BASE DETAIL ALUMINUM SHAFT



**DESCRIPTION**

The classic lines and sophisticated construction of the Vision Site luminaire make it an ideal complement to site design. The combination of smooth contours and sharp rear reveals allows the fixture to change character from different viewing angles while providing excellent low-glare photometrics. U.L. listed and CSA certified for wet locations.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>S2</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Construction**

**HOUSING:** One-piece, die-cast aluminum housing maintains a nominal 0.125" wall thickness. Integral reveal channels along top surface of housing promote heat extraction and prolonged electrical component life. Solid cast wall separates optical chamber from electrical area. **DOOR:** One-piece die-cast aluminum door frame. Door frame opens via release of two flush mounted toolless latches. Tempered 1/8" thick clear glass lens seals to door with a weather-tight continuous gasket. Optical chamber is sealed against entry of dirt and moisture by a continuous door mounted gasket which firmly compresses against optical enclosure walls. **ARM:** One-piece extruded rectangular arm available in standard 6" and 10" lengths. Internal bolt guides allow easy positioning of fixture during installation to pole or wall surface. **STRUCTURAL MOUNT:** Die-cast aluminum cleat factory mounted to luminaire and finished in luminaire color. Stainless steel structural rod measures 1/2" in diameter and is provided in luminaire finish color or optional natural finish. Product

works in conjunction with accessory 10" arms. INVUE poles provided pre-drilled for suspension mount option. See INVUE pole brochure for a complete selection of matching poles.

**Electrical**

**ELECTRICAL TRAY:** Ballast and related electrical componentry are mounted to a reinforced one piece galvanized steel tray with integral handle. For ease of maintenance, tray hinges open via toolless release of one spring loaded latch. Electrical quick disconnects allow tray to be completely removed from housing providing ample hand and tool room for attachment of fixture during installation, and a safer servicing environment. Optional tray mounted fuse connections offer a distinct and easy to maintain alternative to common inline fuse connections.

**Optical**

**LENS:** Impact resistant 1/8" thick tempered clear flat glass. **OPTICAL SYSTEMS:** Choice of five (5) efficiency segmented optical systems constructed of premium 95% reflective anodized aluminum

sheet. Optical segments are rigidly mounted inside a thick gauge aluminum housing for superior protection. All segment faces are clean of rivet heads, tabs, or other means of attachment which may cause streaking in the light distribution. Optional high efficiency hydroformed reflectors available in VXM housing only in four (4) distributions patterns. All reflector modules feature toolless removal, quick disconnect wiring plugs, and are field rotatable in 90 degree increments. HID lamp sources in medium housing (VXM) optics feature mogul-base lampholders.

**Finish**

Housing and arm finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.

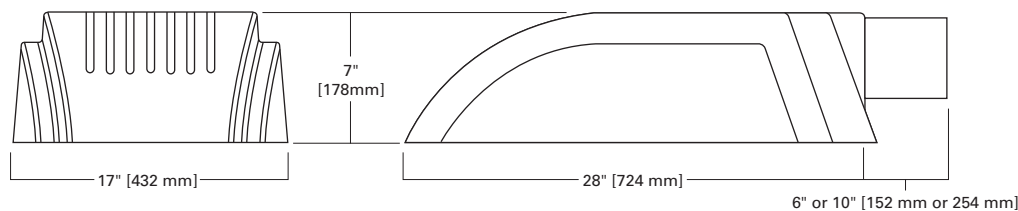


**VXM  
VISION SITE  
MEDIUM**

- 84 - 400W**
- Pulse Start Metal Halide**
- Metal Halide**
- High Pressure Sodium**
- Compact Fluorescent**

**ARCHITECTURAL  
AREA LUMINAIRE**

**DIMENSIONS**



**WATTAGE TABLE**

Lamp Type	Wattage
Pulse Start Metal Halide (MP)®	150, 175, 250, 320, 350, 400W
High Pressure Sodium (HPS)	150, 250, 400W
Metal Halide (MH)	175, 250, 400W
Compact Fluorescent (CF)	(2) 42, (2) 57W

**NOTE:** ®EISA Compliant: 175-400W.



**CERTIFICATION DATA**

- IP54 Rated
- U.L. 1598 Listed
- 1.5G Vibration Tested
- CSA Listed
- 40°C Ambient Temperature Rating
- ISO 9001
- Full Cutoff

**EPA  
Effective Projected Area:**

- (Sq. Ft.)**
- Single: 1.6
- Single Structural: 1.82

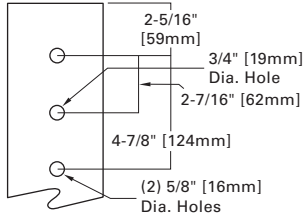
**SHIPPING DATA  
(Approximate)**

- Net Weight (lbs.): 51
- Volume (cu. ft): 3.18



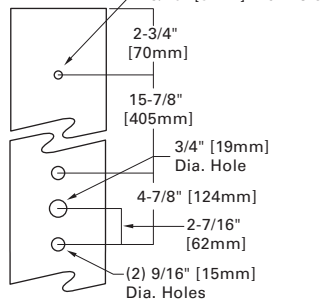
**ARM DRILLING**

**TYPE "M"**

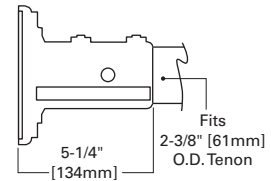


**STRUCTURAL MOUNT**

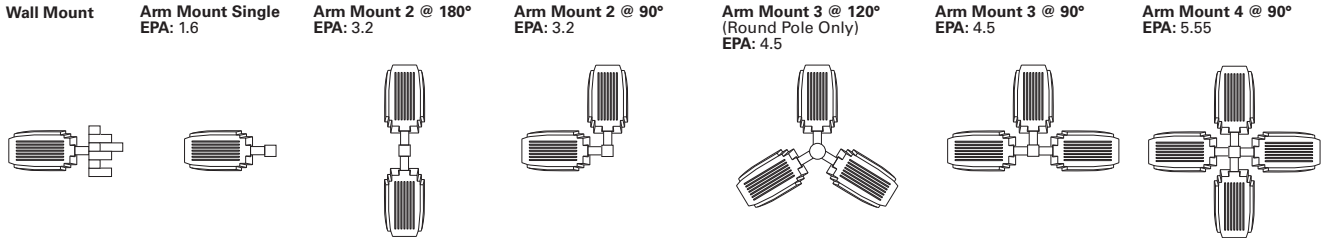
**TYPE "G"**



**MAST ARM ADAPTER**



**MOUNTING VARIATIONS**



NOTE: 1 Assumes 10" arm for 90° and 120° mounting configurations, 6" for all else.

**ORDERING INFORMATION**

Sample Number: VXM-400-MH-MT-3S-BK-PRCPS-L

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**Product Family** <sup>1</sup>  
VXM=Vision Site Medium

**Lamp Wattage** <sup>2</sup>  
MP  
150=150W  
175=175W  
250=250W  
320=320W  
350=350W  
400=400W<sup>3</sup>  
MH <sup>4</sup>  
175=175W  
250=250W  
400=400W<sup>3</sup>  
HPS  
150=150W  
250=250W  
400=400W  
**Compact Fluorescent**  
84=(2) 42W<sup>5</sup>  
114: (2) 57W<sup>5</sup>

**Lamp Type**  
MP=Pulse Start Metal Halide  
MH=Metal Halide  
HPS=High Pressure Sodium  
CF=Compact <sup>6</sup> Fluorescent  
**Voltage** <sup>7</sup>  
120=120V  
208=208V  
240=240V  
277=277V  
347=347V  
480=480V  
DT=Dual-Tap wired<sup>8</sup> 277V  
MT=Multi-Tap wired<sup>9</sup> 277V  
TT=Triple-Tap wired<sup>10</sup> 347V  
UNV=120-277V Universal Electronic Ballast

**Optical System**  
2S=Type II  
3S=Type III  
4S=Type IV  
5S=Type V  
SL=Forward Throw w/ Spill Light Eliminator  
2F=Design 20 Formed  
3F=Design 30 Formed  
4F=Design 40 Formed  
5F=Design 50 Formed  
**Color** <sup>11</sup>  
BK=Black  
AP=Grey  
BZ=Bronze  
WH=White  
DP=Dark Platinum  
GM=Graphite Metallic

**Structural Options** <sup>1, 12</sup>  
**Pole Mount**  
PRCPS=Strut Rod and Clevis Set for Square Pole (Painted to match fixture, does not include arm) <sup>13</sup>  
PRCSS=Stainless Steel Strut Rod and Clevis Set for Square Poles (Clevis' painted to match fixture, does not include arm) <sup>13</sup>  
PRCPR=Strut Rod and Clevis Set for Round Pole (Painted to match fixture, does not include arm) <sup>14</sup>  
PRCSR=Stainless Steel Strut Rod and Clevis Set for Round Poles (Clevis' painted to match fixture, does not include arm) <sup>14</sup>  
**Wall Mount**  
WRCP=Strut Rod and Clevis Set (Painted to match fixture, does not include arm) <sup>15</sup>  
WRCS=Stainless Steel Strut Rod and Clevis Set (Clevis' painted to match fixture, does not include arm) <sup>15</sup>

**Options** <sup>12</sup>  
F: Single Fuse (120, 277 or 347V) Specify Voltage  
FF: Double Fuse (208, 240 or 480V) Specify Voltage  
Q: Quartz Restrike<sup>16</sup>  
EM: Quartz Restrike w/ Time Delay (Also<sup>16</sup> Strikes at Cold Start)  
EM/SC: Quartz Emergency Separate<sup>16</sup> Circuit  
R: NEMA Twistlock Photocell Receptacle  
DS: Dual Fluorescent Switching Control<sup>17</sup>  
HS: House Side Shield<sup>18</sup>  
VS: Polycarbonate Vandal Shield  
T: Terminal Block  
L: Lamp Included

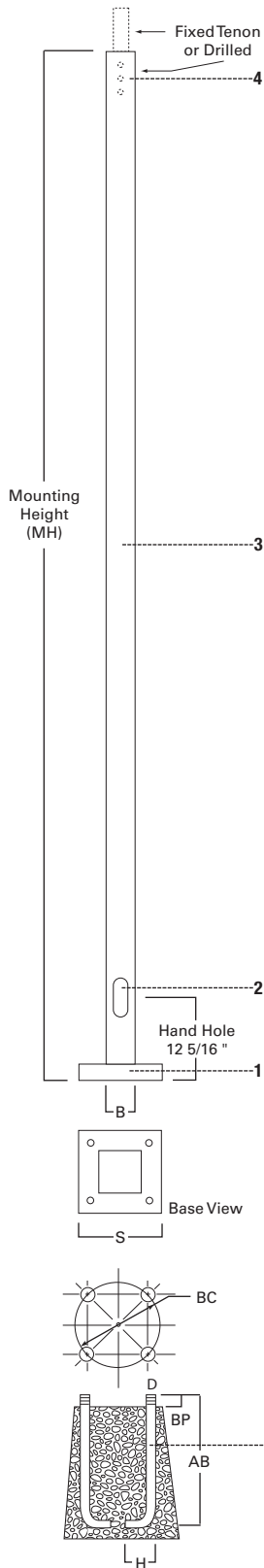
**Accessories** <sup>19</sup>  
MA1050-XX=6" Arm for Square Pole  
MA1051-XX=10" Arm for Square Pole<sup>20</sup>  
MA1052-XX=6" Arm for Round Pole  
MA1053-XX=10" Arm for Round Pole<sup>20</sup>  
MA1054-XX=Wall Bracket with 6" Arm<sup>21</sup>  
MA1056-XX=Direct Mount for Square Pole  
MA1057-XX=Direct Mount for Round Pole  
MA1201-XX=Direct Wall Mount Kit<sup>21</sup>  
MA1207-XX=Mast Arm Adapter  
MA1231-XX=VXM Structural Mount Wall Mount<sup>22</sup> Arm  
MA1017-XX=Single-arm Tenon Adapter for 2 3/8" O.D. Tenon  
MA1018-XX=2@180 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1019-XX=3@120 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1045-XX=4@90 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1048-XX=2@90 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1115-XX=3@90 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1116-XX=2@120 Degree Tenon Adapter for 2 3/8" O.D. Tenon  
MA1010-XX: Single-arm Tenon Adapter for 3 1/2" O.D. Tenon  
MA1011-XX: 2@180 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
MA1012-XX: 3@120 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
MA1013-XX: 4@90 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
MA1014-XX: 2@90 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
MA1015-XX: 2@120 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
MA1016-XX: 3@90 Degree Tenon Adapter for 3 1/2" O.D. Tenon  
OA/RA1016: NEMA Photocontrol - Multi-Tap  
OA/RA1027: NEMA Photocontrol - 480V  
OA/RA1201: NEMA Photocontrol - 347V

**Notes:** 1 Arm not included. See accessories. 2 Standard with mogul-base socket for HPS, MH and 175-400W MP. Standard with medium-base socket for MP lamps 150W and below. 3 400W MH and PSMH requires reduced envelope ED28 lamp. 4 MH products available for non-U.S. markets only. 5 Dual Compact Fluorescent lamp options available in Type 2S with 84 and 114W. Type 3S available in 84W only. 6 CF ballasts are 120 through 277V. Specify with UNV voltage designation. 7 Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information. 8 Dual-tap is 120/277V wired 277V. 9 Multi-tap is 120/208/240/277V wired 277V. 10 Triple-tap is 120/277/347V wired 347V. 11 Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information. 12 Add as suffix in the order shown. 13 Compatible with 10" MA1051 arm only. 14 Compatible with 10" MA1053 arm only. 15 Wall mount structural options do not include arm assembly (See Accessories). Compatible with 10" MA1231 arm only. 16 Quartz options not available with SL optic. 17 Dual switching requires dual 42W or dual 57W Compact Fluorescent lamps. Allows independent switching control of each lamp through use of two (2) electronic ballasts. Allows 50% power reduction when dual ballasts are independently wired and controlled. 18 House side shield not available on 5S and SL optics. 19 Order separately, replace XX with color suffix. 20 Use when mounting fixture heads at 90° increments. 21 For use in down lighting applications only. 22 Includes arm only. Must specify WRCP or WRCS in fixture ordering logic. Down light only.

# SSX=STEEL SQUARE STRAIGHT

10'–39' Mounting Height

Catalog #		Type
Project		S2 Pole
Comments		Date
Prepared by		



## SPECIFICATION FEATURES

- 1 ASTM Grade steel base plate with ASTM A366 base cover.
- 2 Hand hole assembly 3" x 5" on 5" and 6" pole; and 2" x 4" on 4" pole.
- 3 ASTM A500 grade "B" steel shaft. Shot blasted and painted with premium TGIC polyester powder coat.
- 4 Drilled or Tenon (specify).
- 5 Anchor bolt per ASTM A576 with (2) nuts, (2) flat washer, and (1) lock washer. Nuts, washers and threaded portion of bolt are hot dip galvanized. 3" hook for 3/4" bolt. 4" hook for 1" bolt.

POLE COMPATIBILITY MATRIX	DRILL PATTERN	EPA + MOUNTING CONFIGURATIONS					
		Single w/Arm [1]	2 @ 180 [2]	2 @ 90 [5]	3 @ 90 [3]	3 @ 120 [6]	4 @ 90 [4]
ICON SMALL	A	0.69	1.38	1.38	1.84	1.84	2.07
ICON MEDIUM	C	1.09	2.18	2.18	2.86	2.86	3.20
ICON SMALL STRUCTURAL MOUNT	J	0.71	1.42	1.42	1.90	1.90	2.14
ICON MEDIUM STRUCTURAL MOUNT	K	1.11	2.22	2.22	2.92	2.92	3.27
VISION SMALL	E	1.27	2.54	2.54	3.60	3.60	4.13
VISION MEDIUM	M	1.6	3.20	3.20	4.50	4.50	5.55
VISION SMALL STRUCTURAL MOUNT	F	1.28	2.56	2.56	3.63	3.63	4.17
VISION MEDIUM STRUCTURAL MOUNT	G	1.82	3.64	3.64	4.96	4.96	5.62
ASCENT SMALL	A	0.85	1.70	1.70	2.35	2.35	2.68
ASCENT MEDIUM	C	1.35	2.70	2.70	3.83	3.83	4.56
STRUT SMALL	A	1.03	2.06	2.06	2.89	2.89	3.49
STRUT MEDIUM	C	1.64	3.28	3.28	4.70	4.70	5.77
X-FORM SMALL	E	1.15	2.30	2.30	3.20	3.20	3.81
X-FORM MEDIUM	M	2.1	4.20	4.20	6.00	6.00	7.50

See Drill Patterns on page 3.

## FOUR BOLT ANCHORAGE [see ordering information]

PB=Bolt Projection

AB=Bolt Dimensions

D=Bolt Diameter

H=Bolt Dimensions



# S2 Pole

The following information illustrates the correct way to enter an order for SSX5A20SGMM1G. The ordering designation is detailed as follows.

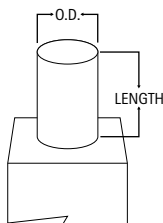
Steel	Square	Straight	Shaft <sup>3</sup>	Wall Thickness	Mounting Height (ft.)	Base Type	Colors	Fixture Mounting + Type	No. + Location of Arms	Accessories (Ground Lug)
S	S	X	5	A	20	S	GM	M	1	G

Mtg. Height MH	Catalog Number	Wall Thickness	Base Square (In.)	Bolt Circle Dia. (In.)	Bolt Proj. (In.)	Shaft Size (In.)	Anchor Bolt Dia. + Length (In.)	Net. Wt. (Lbs.)	EPA (Sq. Ft.) <sup>4</sup> At Pole Top				EPA (Sq. Ft.) <sup>4</sup> 2' Above Pole Top				Max. Fixture Load—Include Bracket (Lbs.)
									70	80	90	100	70	80	90	100	
10	SSX4A10SBZ	.120	10 1/2	11.0	4 1/2	4	3/4 x 25 x 3	96	39.8	29.9	23.2	18.4	33.0	24.8	19.3	15.3	150
15	SSX4A15SBZ	.120	10 1/2	11.0	4 1/2	4	3/4 x 25 x 3	133	19.6	14.4	10.8	8.2	17.2	12.7	9.5	7.3	150
20	SSX4A20SBZ	.120	10 1/2	11.0	4 1/2	4	3/4 x 25 x 3	152	12.9	9.1	6.5	4.6	11.7	8.2	5.9	4.2	200
25	SSX4A25SBZ	.120	10 1/2	11.0	4 1/2	4	3/4 x 25 x 3	208	8.7	5.6	3.6	2.1	8.0	5.2	3.3	2.0	200
20	SSX5A20SBZ	.120	10 1/2	11.0	4 1/2	5	3/4 x 25 x 3	202	21.9	15.7	11.6	8.5	19.9	14.3	10.5	7.7	200
25	SSX5A25SBZ	.120	10 1/2	11.0	4 1/2	5	3/4 x 25 x 3	248	15.5	10.5	7.2	4.8	14.3	9.8	6.6	4.4	200
30	SSX5A30SBZ	.120	10 1/2	11.0	4 1/2	5	3/4 x 25 x 3	293	8.2	4.6	2.1	--	7.7	4.3	2.0	--	300
35	SSX5M35SBZ	.188	10 1/2	11.0	4 1/2	5	3/4 x 25 x 3	480	11.8	7.1	3.8	1.5	11.1	6.6	3.6	1.4	300
25	SSX6A25SBZ	.120	12 1/2	12.5	5	6	1 x 36 x 4	295	24.1	16.8	12.0	8.5	22.2	15.6	11.1	7.8	200
30	SSX6A30SBZ	.120	12 1/2	12.5	5	6	1 x 36 x 4	347	14.0	8.7	5.0	2.5	13.1	8.2	4.7	2.3	300
30	SSX6M30SBZ	.188	12 1/2	12.5	5	6	1 x 36 x 4	505	26.4	18.1	12.5	8.4	24.7	16.9	11.6	7.9	300
35	SSX6M35SBZ	.188	12 1/2	12.5	5	6	1 x 36 x 4	584	19.7	12.7	7.9	4.4	18.6	12.0	7.5	4.2	300
35	SSX6X35SBZ	.250	12 1/2	12.5	5	6	1 x 36 x 4	696	28.9	19.7	13.4	8.9	8.7	18.6	12.7	8.4	300
39	SSX6M39SBZ	.188	12 1/2	12.5	5	6	1 x 36 x 4	647	15.4	9.1	4.8	1.8	14.6	8.7	4.6	1.7	300
39	SSX6X39SBZ	.250	12 1/2	12.5	5	6	1 x 36 x 4	822	23.5	15.4	9.8	5.7	22.4	14.6	9.3	5.4	300

- NOTES: 1 Catalog number includes pole with anchor bolts with double nuts (BEFORE INSTALLING ANCHOR BOLTS MAKE SURE PROPER ANCHOR BOLT TEMPLATE IS OBTAINED FROM COOPER LIGHTING).  
 2 Tenon size or machining for rectangular arms must be specified. Hand hole is located 180° from single arm.  
 3 Shaft size, base plate, anchor bolts and projections may vary slightly—all dimensions nominal.  
 4 EPA's based on shaft properties with wind normal to flat. EPA's calculated using base wind velocity as indicated plus 30% gust factor.

**MOUNTING OPTIONS=FIXED TENON [add as suffix]**

Designation Number	O.D. (in.)	Length (in.)
1	2 3/8"	3 1/2"
2	2 3/8"	4"
3	3 1/2"	5"
5	3"	4"



**ACCESSORIES**

- A=1/2" Tapped Hub <sup>1</sup>
- B=3/4" Tapped Hub <sup>1</sup>
- C=Convenience Outlet <sup>2</sup>
- G=Grounding Lug  
(Max. Wire #8 AWG)
- H=Additional Hand Hole and Cover  
(12" Below Pole Top—90° from Hand Hole)

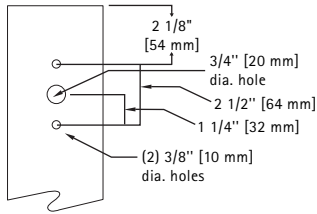
- NOTES=1 Location is 3' above base 90° from hand hole.  
 2 Outlet is located 4' above base and on same side of pole as hand hole, unless specified otherwise. Receptacle not included, provision only.

NOTE: Specifications and dimensions subject to change without notice.

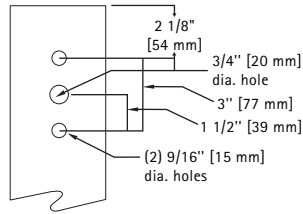
# S2 Pole

## DRILL PATTERNS

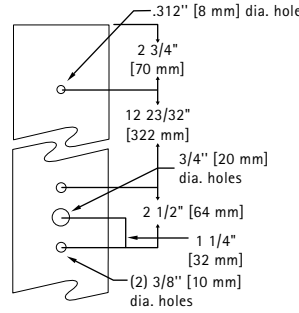
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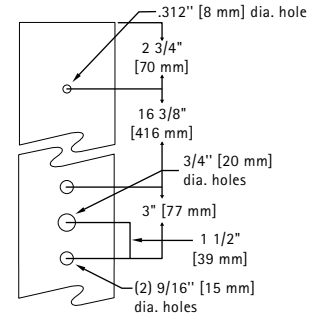
(TYPE "C")



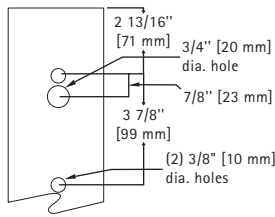
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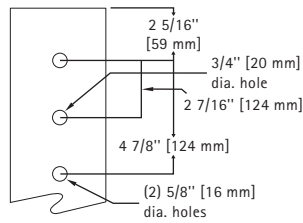
(TYPE "K")



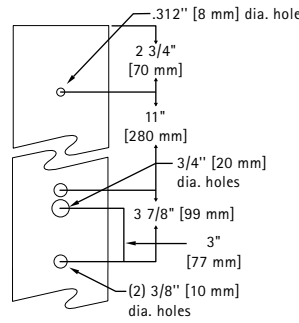
(TYPE "E")



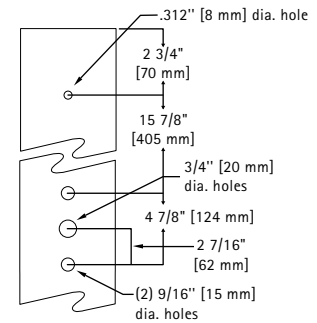
(TYPE "M")



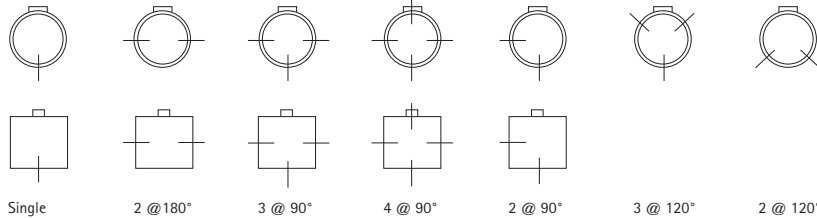
(TYPE "F")



(TYPE "G")



## FIXTURE DRILLING OPTIONS [Note handhole position relative to drill locations]



**CAUTION:** Cooper Lighting poles have been designed to support only the luminaires and equipment originally intended. Miscellaneous items such as pennants, signs, and decorations may cause pole failure because of overloading. Addition of these items voids The Cooper Lighting warranty. Cooper Lighting will, however, supply information regarding total loading capacity on request. Cooper Lighting poles are guaranteed only when used in a pole/luminaire or floodlight combination. Any other application of poles, including application without a luminaire or floodlight, voids Cooper Lighting's warranty.

NOTE: Specifications and dimensions subject to change without notice.



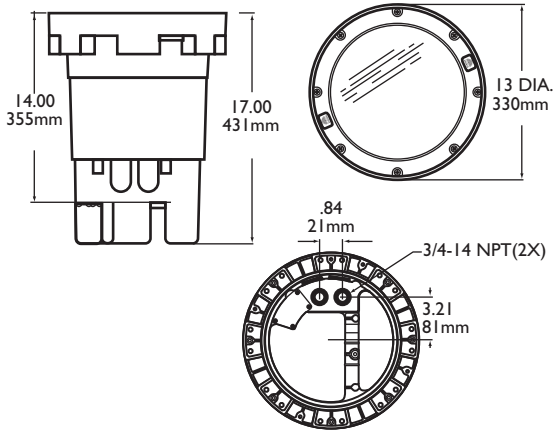
LSI GREENLEE RDB/RDS SERIES

INGROUND UPLIGHT

RDB



DIMENSIONS



**Lamp Types:** Metal Halide, High Pressure Sodium, Incandescent, Low-Voltage, and Compact Fluorescent

**Housing:** Compression molded, fiber-reinforced polymer housing provides high strength and UV stability. Warranted against corrosion for five years.

**Finish:** Housing and standard slip-resistant composite lens retainer is black. Optional aluminum accessories are available in Black or Clear polyester powder coat. Brass accessories have a natural, as cast finish.

**Fasteners:** All exposed fasteners are captive, black oxide coated, stainless steel.

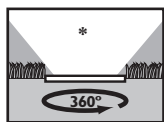
**Lampholder:** Matched to lamp/optics. Medium base is glazed porcelain, 4KV pulse rated, with spring center contact. Double ended HID are 5KV pulse rated with silver plated contacts. Compact fluorescent are molded thermoplastic. LV Bi-pin are high temperature ceramic. GX10 twist-lock ceramic sockets for CMH MR16 lamps.

**Lens/Retainer:** Tempered, heat resistant glass available with low-iron formulation or optional slip resistant etched pattern. Cast brass and aluminum lens retainers are available in place of standard composite ring.

with variable beams spreads are available. Precise beam spread, tilt, and rotation can all be locked into place. Max reflector tilt is 15° in RDS, and 25° in RDB. Spot optics come standard with Internal Source Shields for glare control. Wall Wash optics have integral glare control devices. Reflector lamps from MR16 (RDS) through PAR38 (RDB) can be accommodated.

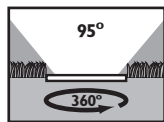
**Power Pack:** Standard HID PPK is magnetic, high power factor, -20°F starting, with a Class H, 180°C insulation system. Ballast and thermal protector are encapsulated in silica resin for heat control. PPK assembly has handle/finger holes for easy installation and service. Dissimilar quick connectors ensure error free assembly. Molded-in compartments (in housing) separate capacitor and ignitor from ballast heat. Fluorescent ballast is electronic, universal 120-277V 50/60HZ, rated for 0°F starting. Electronic ballasts for most metal halide lamps are an available option. Seal Pack and waterproof wire connectors are included to provide for a high quality installation.

RDB OPTICS

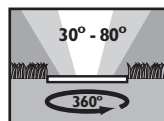


**SWW**  
CMH 39, 70, 150, T6

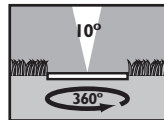
\* Wall Wash



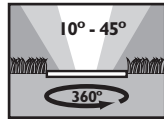
**FLF**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



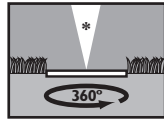
**FLV**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



**SPF-Fixed Spot**  
MH 50, 70, 100, 150  
Tilt up to 25°



**SPV-Variable Spot**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



**RFL/PAR38**  
MH 39, 70, 100  
\*Depends on Lamp  
Tilt up to 25°

**Optics/Aiming:** Flood and Spot optics



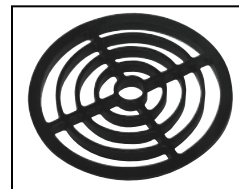
**ARRA**  
Funding Compliant



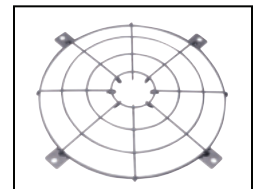
RDB Accessories (only)



Internal Directional Louver (IDL)



Internal Non-Directional Louver (INL)



Stainless Steel Rock Guard (RGS)  
RGS is Black Oxide Coated

For RDB - RTL is restricted to 100W max. and cannot be used with AWW or SWW optics.

# LSI GREENLEE RDB/RDS SERIES

## INGROUND UPLIGHT

LSI GREENLEE's RDB/RDS family of round corrosion proof composite inground uplights provides these extra value features:

- RTL technology significantly reduces lens temperatures
- Variable Beam Spread Optics
- Rough-in housing RIH (with lens and retainer) can be shipped ahead for installation in concrete.
- Drive-over capability, up to 3,000-pound vehicle weight
- Power Pack with Quick Connectors
- Interchangeable Optic Assemblies with Quick Connectors
- Seal Pack kit provided to seal junction box for a high quality installation
- Waterproof wire connectors provided for trouble-free operation
- Anti-Siphon Barrier
- Tempered Low Iron Glass Lens

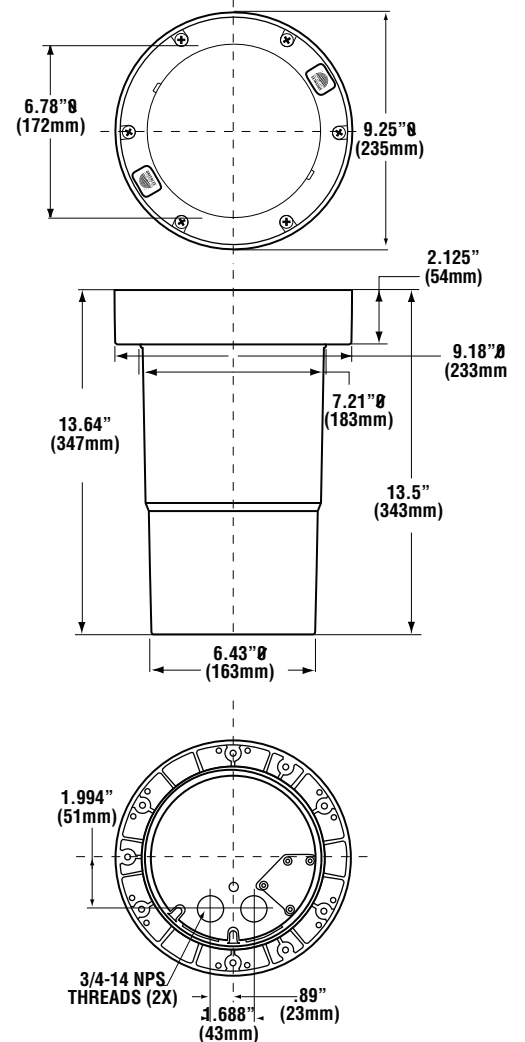


### RDS OPTICS

	<b>AWW</b> CMH 39, 70 MH 50, 70, 100 HPS 50, 70, 100 * Wall Wash
	<b>FLF</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>FLV</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>SPF</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>SPV</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>RFL</b> MR16 MH 20, 39, 70, 100PAR *Depends on Lamp Tilt up to 15°



### DIMENSIONS



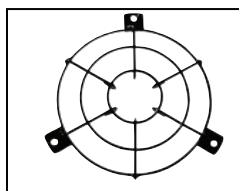
### RDS Accessories (only)



**Domed Directional Marker**  
DMB-Shown  
DMA-CPP Available  
DMA-BLK Available



**Wall Wash Lens**  
Standard w/AWW Optics



**Stainless Steel Rock Guard**  
RGS-Shown

For RDS - RTL is restricted to 70W max. and cannot be used with AWW optics.

# LSI GREENLEE RDB/RDS ORDER SPECIFICATIONS

## LUMINAIRE ORDERING INFORMATION

TYPICAL ORDER EXAMPLE: **RDB 100MH 120 FLV IDL**

Series	Wattage/Lamp Type	Voltage	Optics	Options
RDB	39, 50, 70, 100, 150 MH	120 208 240 277	<b>Optics for Medium Base E-17 Lamps</b> FLV – Variable Flood 30°– 80° SPV – Variable Spot 10°– 45° AWW – Asymmetric Wall Wash Optics (for E-17 lamps) FLF – Fixed Flood Reflector 95° SPF – Fixed Spot Reflector 10° <b>Optics for T6 CMH Lamps w/G12 bi-pin base</b> SWW – Superior Wall Wash Optics (for T-6 lamps) FLVG12 – Variable Flood 30°– 80° <sup>3</sup> SPVG12 – Variable Spot 10°– 45° <sup>3</sup> <b>Self Reflectorized Lamp Optics</b> PAR38: Med Base PAR38 Lamps MH 70, 100, 150	ALR – Aluminum Lens Retainer- Specify Color <sup>4</sup> BLR – Brass Lens Retainer LL – Less Lamp RGA – Rock Guard Aluminum – Specify Color <sup>4</sup> RGB – Rock Guard Brass SCE – Side Conduit Entry (two additional, 3/4-14 only) SRL – Slip Resistant Lens DSA – Directional Shield Aluminum – Specify Color <sup>4</sup> DSB – Directional Shield Brass
	INC	120	PAR38:Medium Base/Up to 250 watt AWW– Up to 150 watt T-10 halogen	<b>Accessories</b> CFX – Color Filters <sup>5</sup> IDL – Internal Directional Louver RGS – Stainless Steel Rock Guard <sup>6</sup> RTL – Reduced Temperature Lens <sup>5</sup> SST– Stainless Steel Trim TDF – Tie Down Fasteners TR – Tamper Resistant Fasteners – order TR key separately TRKEY – Key for TR fasteners
	26, 32,42 CFL	UE <sup>2</sup>	CFF Compact Fluorescent Flood	
RDS Marker	50MH 26, 32, 42 CFL	120 208 240 277 UE <sup>2</sup>	DMA – Domed Directional Marker - Aluminum DMB – Domed Directional Marker - Brass	<b>Options</b> 180 - 180° House Side Shield
RDS Uplight	39, 50, 70, 100 MH	120 208 240 277	<b>Optics for Medium Base E-17 Lamps</b> FLV – Variable Flood 36°– 110° SPV – Variable Spot 15°– 90° AWW – Asymmetric Wall Wash Optics FLF – Fixed Flood Reflector 90° SPF – Fixed Spot Reflector 15° Self Reflectorized Lamp Optics RFL – Up to 100W MH PAR38 or 39, 70W MH PAR30 <b>Optics for T6 CMH lamps with G12 Bi-Pin Base</b> FLVG12 – Variable Flood 30° – 90° <sup>3</sup> SPVG12 – Variable Spot 18° – 60° <sup>3</sup>	<b>Options</b> ALR – Aluminum Lens Retainer–Specify Color <sup>4</sup> BLR – Brass Lens Retainer LL – Less Lamp RGA – Rock Guard Aluminum –Specify Color <sup>4</sup> RGB – Rock Guard Brass SCE – Side Conduit Entry (two additional, 3/4-14 only) SRL – Slip Resistant Lens DSA – Directional Shield Aluminum–Specify Color <sup>4</sup> DSB – Directional Shield Brass
	INC Up to 150W PAR38 lamp or T-10 Halogen Lamp	120	RFL – Up to 150W PAR38 or 75W PAR30 AWW-Up to 150W T-10 Halogen	<b>Accessories</b> CFX – Color Filters <sup>5</sup> HL – Internal Hexcell Louver RGS – Stainless Steel Rock Guard <sup>5</sup> RTL – Reduced Temperature Lens <sup>5</sup> SST – Stainless Steel Trim TDF – Tie Down Fasteners TR – Tamper Resistant Fasteners – order TR key separately TR Key – Key for TR Fasteners INL - Internal Louver <sup>7</sup>
	26, 32,42 CFL	UE <sup>2</sup>	CFF – Compact Fluorescent Flood	
	LV	LV	MR16S - Single MR16 up to 65 watts MR16D - Dual MR16's up to 50 watts each	
	20, 39 MH	UE <sup>2</sup>	MR16S - Single MR16 up to 39 watts MR16D - Dual MR16's up to 39 watts each	

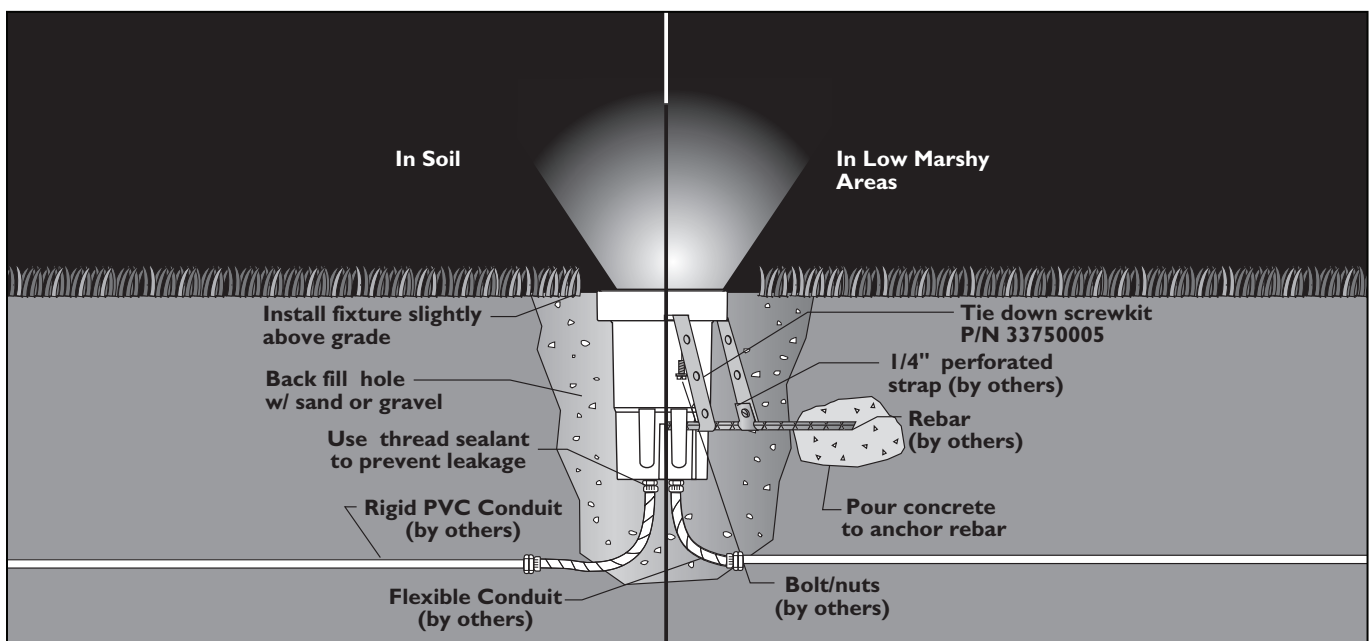
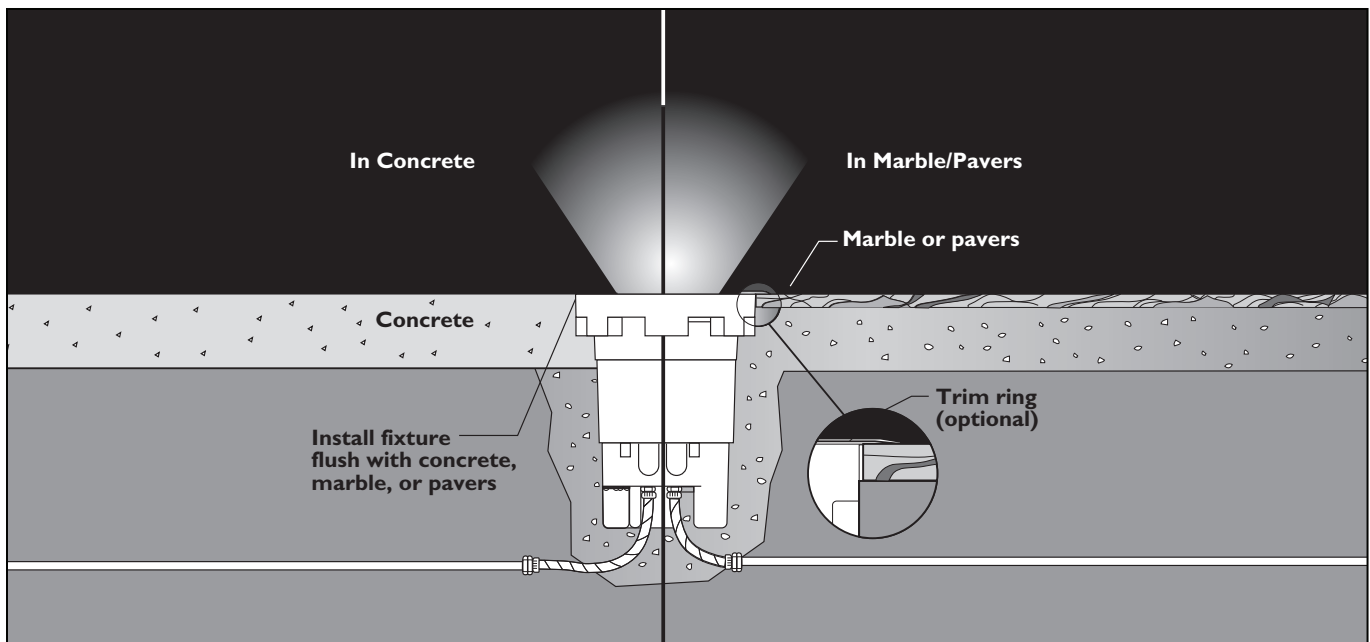
### FOOTNOTES:

- Available in 120 V or 277 V only; 35 Watt HPS is available in 120V only.
- Universal Electronic 120-277V 50 or 60 HZ Ballast.
- FLVG12 and SPVG12 Optics are designed for use with T-6 Ceramic Metal Halide lamps with G12 bases. Available in 39 and 70 watts only in RDS and up to 150 MH in RDB.
- Aluminum and Brass Lens Retainer, Rock Guard, and Directional Shield are available with CPP - Clear or BLK- Black Polyester Powder Coat.
- Restricted use item. Consult web site or factory for details.
- RGS is black oxide coated.
- Not used with SPV 612.

**Use of RTL, color filters, louvers, or other accessories that block light Lowers Maximum Wattage rating. Consult catalog, web site or factory for details.**

## LSI GREENLEE RDB/RDS INSTALLATION

- Follow complete installation instructions packaged with each luminaire (also available on our web site)
- Use flexible PVC conduit and apply thread sealant to all conduit fittings
- Connect supply and fixture wires with silicone filled connectors (supplied)
- Seal conduit entries (around wires - from inside j-box) using mastic in Seal Pack
- Encapsulate conduit entries and wires with potting compound supplied in Seal Pack
- Install junction box cover and properly tighten all fasteners
- Install Power Pack – PPK, Access Barrier Plate, and Optics as instructed
- Clean lens gasket and gasket seating surface (fixture flange)
- Install lens, lens retainer (or replacement accessory), and fasteners
- Using an alternating torque sequence, tighten fasteners until lens frame seats against housing.



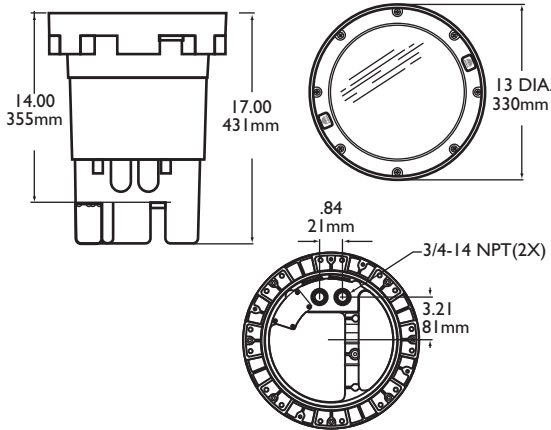
LSI GREENLEE RDB/RDS SERIES

INGROUND UPLIGHT

RDB



DIMENSIONS



**Lamp Types:** Metal Halide, High Pressure Sodium, Incandescent, Low-Voltage, and Compact Fluorescent

**Housing:** Compression molded, fiber-reinforced polymer housing provides high strength and UV stability. Warranted against corrosion for five years.

**Finish:** Housing and standard slip-resistant composite lens retainer is black. Optional aluminum accessories are available in Black or Clear polyester powder coat. Brass accessories have a natural, as cast finish.

**Fasteners:** All exposed fasteners are captive, black oxide coated, stainless steel.

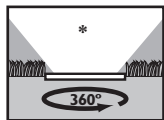
**Lampholder:** Matched to lamp/optics. Medium base is glazed porcelain, 4KV pulse rated, with spring center contact. Double ended HID are 5KV pulse rated with silver plated contacts. Compact fluorescent are molded thermoplastic. LV Bi-pin are high temperature ceramic. GX10 twist-lock ceramic sockets for CMH MR16 lamps.

**Lens/Retainer:** Tempered, heat resistant glass available with low-iron formulation or optional slip resistant etched pattern. Cast brass and aluminum lens retainers are available in place of standard composite ring.

with variable beams spreads are available. Precise beam spread, tilt, and rotation can all be locked into place. Max reflector tilt is 15° in RDS, and 25° in RDB. Spot optics come standard with Internal Source Shields for glare control. Wall Wash optics have integral glare control devices. Reflector lamps from MR16 (RDS) through PAR38 (RDB) can be accommodated.

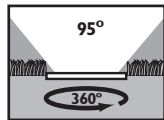
**Power Pack:** Standard HID PPK is magnetic, high power factor, -20°F starting, with a Class H, 180°C insulation system. Ballast and thermal protector are encapsulated in silica resin for heat control. PPK assembly has handle/finger holes for easy installation and service. Dissimilar quick connectors ensure error free assembly. Molded-in compartments (in housing) separate capacitor and ignitor from ballast heat. Fluorescent ballast is electronic, universal 120-277V 50/60HZ, rated for 0°F starting. Electronic ballasts for most metal halide lamps are an available option. Seal Pack and waterproof wire connectors are included to provide for a high quality installation.

RDB OPTICS

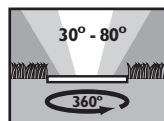


**SWW**  
CMH 39, 70, 150, T6

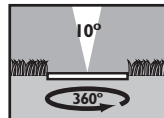
\* Wall Wash



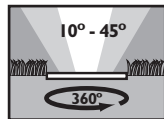
**FLF**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



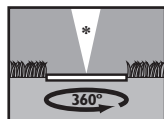
**FLV**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



**SPF-Fixed Spot**  
MH 50, 70, 100, 150  
Tilt up to 25°



**SPV-Variable Spot**  
MH 50, 70, 100, 150  
HPS 50, 70, 100, 150  
Tilt up to 25°



**RFL/PAR38**  
MH 39, 70, 100  
\*Depends on Lamp  
Tilt up to 25°

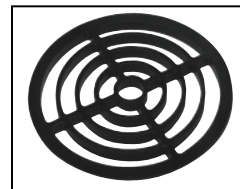
**Optics/Aiming:** Flood and Spot optics



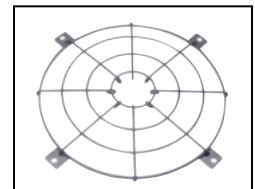
RDB Accessories (only)



Internal Directional Louver (IDL)



Internal Non-Directional Louver (INL)



Stainless Steel Rock Guard (RGS)  
RGS is Black Oxide Coated

For RDB - RTL is restricted to 100W max. and cannot be used with AWW or SWW optics.



# LSI GREENLEE RDB/RDS SERIES

## INGROUND UPLIGHT

LSI GREENLEE's RDB/RDS family of round corrosion proof composite inground uplights provides these extra value features:

- RTL technology significantly reduces lens temperatures
- Variable Beam Spread Optics
- Rough-in housing RIH (with lens and retainer) can be shipped ahead for installation in concrete.
- Drive-over capability, up to 3,000-pound vehicle weight
- Power Pack with Quick Connectors
- Interchangeable Optic Assemblies with Quick Connectors
- Seal Pack kit provided to seal junction box for a high quality installation
- Waterproof wire connectors provided for trouble-free operation
- Anti-Siphon Barrier
- Tempered Low Iron Glass Lens

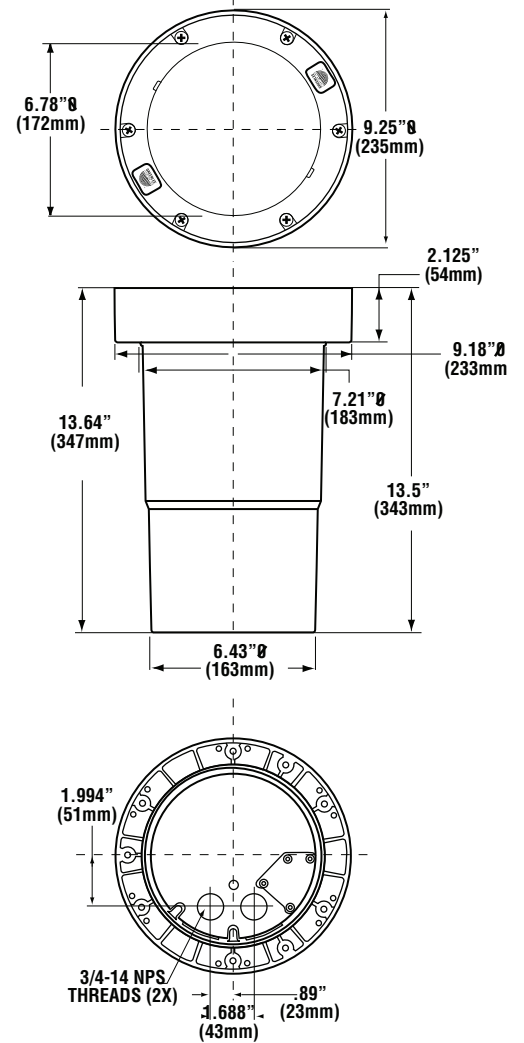


### RDS OPTICS

	<b>AWW</b> CMH 39, 70 MH 50, 70, 100 HPS 50, 70, 100 * Wall Wash
	<b>FLF</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>FLV</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>SPF</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>SPV</b> MH 50, 70, 100 HPS 50, 70, 100 Tilt up to 15°
	<b>RFL</b> MR16 MH 20, 39, 70, 100PAR *Depends on Lamp Tilt up to 15°



### DIMENSIONS



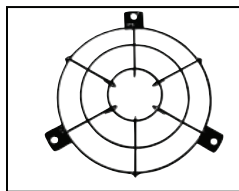
### RDS Accessories (only)



**Domed Directional Marker**  
DMB-Shown  
DMA-CPP Available  
DMA-BLK Available



**Wall Wash Lens**  
Standard w/AWW Optics



**Stainless Steel Rock Guard**  
RGS-Shown

For RDS - RTL is restricted to 70W max. and cannot be used with AWW optics.

# LSI GREENLEE RDB/RDS ORDER SPECIFICATIONS

## LUMINAIRE ORDERING INFORMATION

TYPICAL ORDER EXAMPLE: **RDB 100MH 120 FLV IDL**

Series	Wattage/Lamp Type	Voltage	Optics	Options
RDB	39, 50, 70, 100, 150 MH	120 208 240 277	<b>Optics for Medium Base E-17 Lamps</b> FLV – Variable Flood 30°– 80° SPV – Variable Spot 10°– 45° AWW – Asymmetric Wall Wash Optics (for E-17 lamps) FLF – Fixed Flood Reflector 95° SPF – Fixed Spot Reflector 10° <b>Optics for T6 CMH Lamps w/G12 bi-pin base</b> SWW – Superior Wall Wash Optics (for T-6 lamps) FLVG12 – Variable Flood 30°– 80° <sup>3</sup> SPVG12 – Variable Spot 10°– 45° <sup>3</sup> <b>Self Reflectorized Lamp Optics</b> PAR38: Med Base PAR38 Lamps MH 70, 100, 150	ALR – Aluminum Lens Retainer- Specify Color <sup>4</sup> BLR – Brass Lens Retainer LL – Less Lamp RGA – Rock Guard Aluminum – Specify Color <sup>4</sup> RGB – Rock Guard Brass SCE – Side Conduit Entry (two additional, 3/4-14 only) SRL – Slip Resistant Lens DSA – Directional Shield Aluminum – Specify Color <sup>4</sup> DSB – Directional Shield Brass
	INC	120	PAR38:Medium Base/Up to 250 watt AWW– Up to 150 watt T-10 halogen	<b>Accessories</b> CFX – Color Filters <sup>5</sup> IDL – Internal Directional Louver RGS – Stainless Steel Rock Guard <sup>6</sup> RTL – Reduced Temperature Lens <sup>5</sup> SST– Stainless Steel Trim TDF – Tie Down Fasteners TR – Tamper Resistant Fasteners – order TR key separately TRKEY – Key for TR fasteners
	26, 32,42 CFL	UE <sup>2</sup>	CFF Compact Fluorescent Flood	
RDS Marker	50MH 26, 32, 42 CFL	120 208 240 277 UE <sup>2</sup>	DMA – Domed Directional Marker - Aluminum DMB – Domed Directional Marker - Brass	
RDS Uplight	39, 50, 70, 100 MH	120 208 240 277	<b>Optics for Medium Base E-17 Lamps</b> FLV – Variable Flood 36°– 110° SPV – Variable Spot 15°– 90° AWW – Asymmetric Wall Wash Optics FLF – Fixed Flood Reflector 90° SPF – Fixed Spot Reflector 15° Self Reflectorized Lamp Optics RFL – Up to 100W MH PAR38 or 39, 70W MH PAR30 <b>Optics for T6 CMH lamps with G12 Bi-Pin Base</b> FLVG12 – Variable Flood 30° – 90° <sup>3</sup> SPVG12 – Variable Spot 18° – 60° <sup>3</sup>	<b>Options</b> ALR – Aluminum Lens Retainer–Specify Color <sup>4</sup> BLR – Brass Lens Retainer LL – Less Lamp RGA – Rock Guard Aluminum –Specify Color <sup>4</sup> RGB – Rock Guard Brass SCE – Side Conduit Entry (two additional, 3/4-14 only) SRL – Slip Resistant Lens DSA – Directional Shield Aluminum–Specify Color <sup>4</sup> DSB – Directional Shield Brass
	INC Up to 150W PAR38 lamp or T-10 Halogen Lamp	120	RFL – Up to 150W PAR38 or 75W PAR30 AWW-Up to 150W T-10 Halogen	<b>Accessories</b> CFX – Color Filters <sup>5</sup> HL – Internal Hexcell Louver RGS – Stainless Steel Rock Guard <sup>5</sup> RTL – Reduced Temperature Lens <sup>5</sup> SST – Stainless Steel Trim TDF – Tie Down Fasteners TR – Tamper Resistant Fasteners – order TR key separately TR Key – Key for TR Fasteners INL - Internal Louver <sup>7</sup>
	26, 32,42 CFL	UE <sup>2</sup>	CFF – Compact Fluorescent Flood	
	LV	LV	MR16S - Single MR16 up to 65 watts MR16D - Dual MR16's up to 50 watts each	
	20, 39 MH	UE <sup>2</sup>	MR16S - Single MR16 up to 39 watts MR16D - Dual MR16's up to 39 watts each	

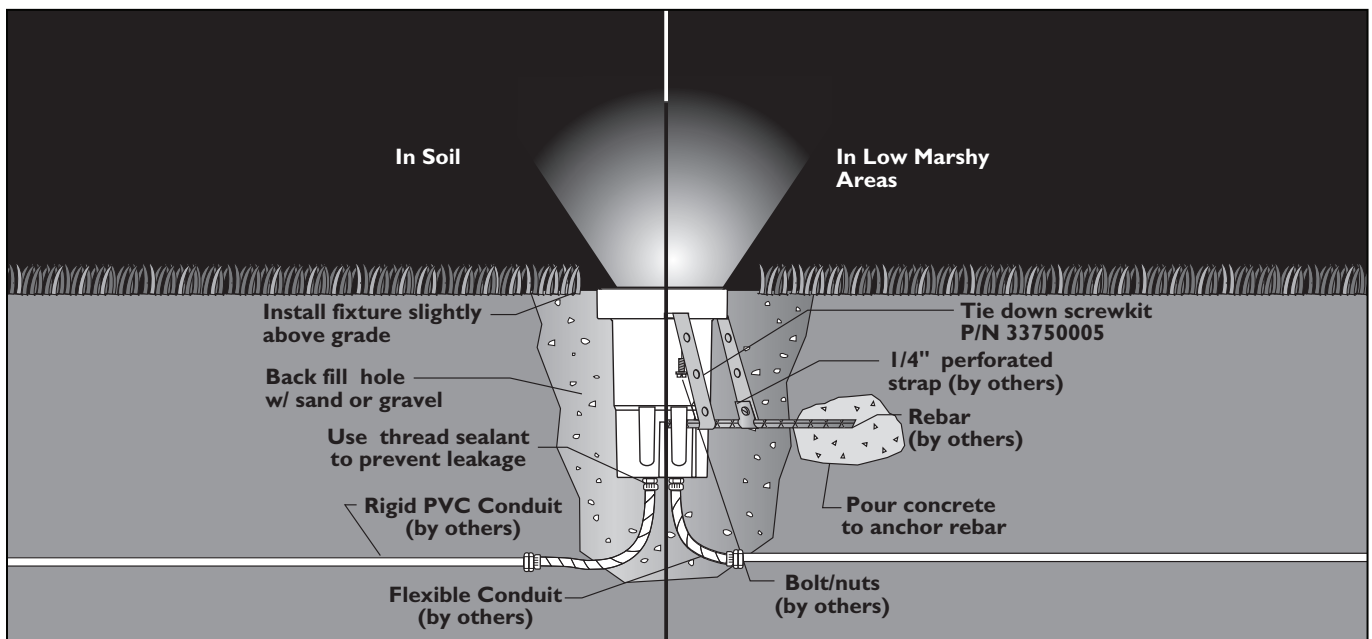
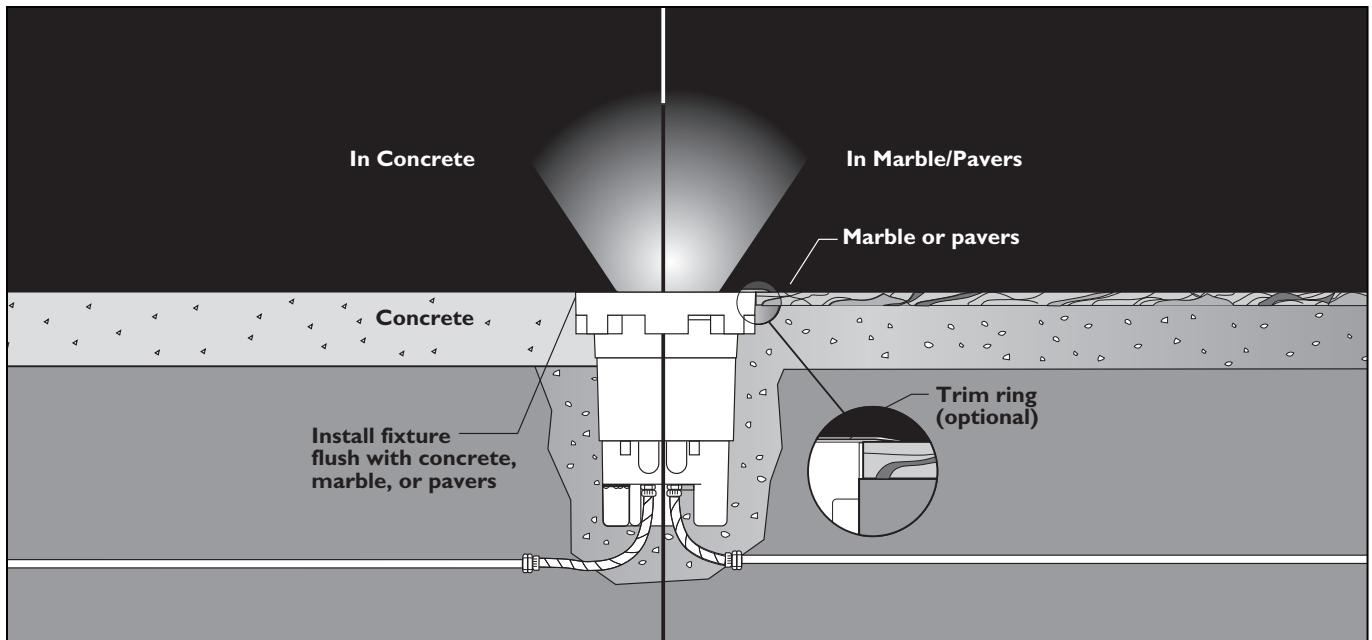
### FOOTNOTES:

- Available in 120 V or 277 V only; 35 Watt HPS is available in 120V only.
- Universal Electronic 120-277V 50 or 60 HZ Ballast.
- FLVG12 and SPVG12 Optics are designed for use with T-6 Ceramic Metal Halide lamps with G12 bases. Available in 39 and 70 watts only in RDS and up to 150 MH in RDB.
- Aluminum and Brass Lens Retainer, Rock Guard, and Directional Shield are available with CPP - Clear or BLK- Black Polyester Powder Coat.
- Restricted use item. Consult web site or factory for details.
- RGS is black oxide coated.
- Not used with SPV 612.

**Use of RTL, color filters, louvers, or other accessories that block light Lowers Maximum Wattage rating. Consult catalog, web site or factory for details.**

## LSI GREENLEE RDB/RDS INSTALLATION

- Follow complete installation instructions packaged with each luminaire (also available on our web site)
- Use flexible PVC conduit and apply thread sealant to all conduit fittings
- Connect supply and fixture wires with silicone filled connectors (supplied)
- Seal conduit entries (around wires - from inside j-box) using mastic in Seal Pack
- Encapsulate conduit entries and wires with potting compound supplied in Seal Pack
- Install junction box cover and properly tighten all fasteners
- Install Power Pack – PPK, Access Barrier Plate, and Optics as instructed
- Clean lens gasket and gasket seating surface (fixture flange)
- Install lens, lens retainer (or replacement accessory), and fasteners
- Using an alternating torque sequence, tighten fasteners until lens frame seats against housing.





**DESCRIPTION**

The simple geometric form of MESA allows it to adapt to either contemporary or traditional architectural settings. Available in single or twin pole mount configurations with optional wall mounting capability, MESA mounting options allow for harmonized site design whether at the entryway or in the parking lot.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>S4</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Construction**

**HOUSING:** Die-cast aluminum main housing and cast aluminum spider mount base maintain a minimum .125 wall thickness and utilize continuous silicone gasketing between castings for a forbidding seal. Four (4) inset quick release fasteners on underside of housing provide access to luminaire interior. **DOOR ASSEMBLY:** Top mounted, heavy wall, die-cast aluminum door maintains a nominal .125 thickness. Continuous silicone gasketing provides IP66 compliant seal to both housing and assembly. Concealed, stainless steel four (4) bar hinge lock allows opened door to lock into place in the open position for servicing the luminaire.

**Electrical**

**ELECTRICAL TRAY:** Ballast and related electrical components are mounted to a reinforced once-piece tray. In line quick disconnects allow

tray to be removed from housing without the use of tools.

**Optical**

**LENS:** Impact resistant 1/8" tempered clear or optional frosted flat glass for concealment of lamp image. Optional clear or frosted tempered sag glass lens improves fixture visibility while providing a subtle performance gain. **OPTICAL SYSTEMS:** Choice of five (5) high efficiency segmented optical systems constructed of premium 95% reflective anodized aluminum sheet. Optical segments are rigidly mounted inside a heavy wall aluminum housing for superior protection. All segment faces are clean of rivet heads, tabs or other means of attachment which may cause streaking in the light distribution. All reflector modules feature toolless removal, quick disconnect wiring and are toolless field rotatable in 90 degree increments. 250W-400W HID lamp

sources feature mogul-base lampholders, while 50-175W HID wattages feature medium-base lampholders.

**Mounting**

Fitter assembly mounts over 3" O.D. Tenon via three (3) concealed, stainless steel set screws and provides seamless transition to 4" round poles.

**Finish**

Housing and arm finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, graphite metallic and hartford green. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.



**MSA MESA**

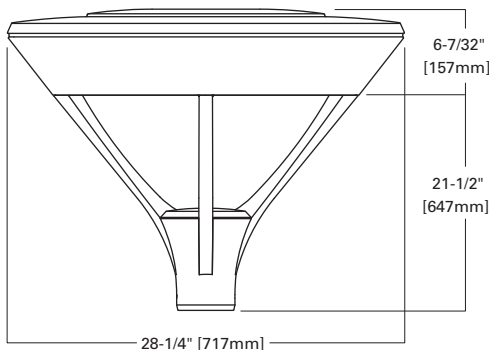
**42 - 400W**

- Pulse Start Metal Halide
- Metal Halide
- High Pressure Sodium
- Compact Fluorescent

**DECORATIVE AREA LUMINAIRE**



**DIMENSIONS**



**WATTAGE TABLE**

Lamp Type	Wattage
Pulse Start Metal Halide (MP)®	50, 70, 100, 150, 175, 250, 320, 350, 400W
High Pressure Sodium (HPS)	50, 70, 100, 150, 250, 400W
Metal Halide (MH)	175, 250, 400W
Compact Fluorescent (CF)	(1) 42, (1) 57, (2) 42, (2) 57W

NOTE: ®EISA Compliant: 175-400W.

**CERTIFICATION DATA**

- IP66 Rated
- U.L. 1598 Listed
- 2G Vibration Tested
- CSA Listed
- 25°C Ambient Temperature Rating
- ISO 9001
- Cutoff

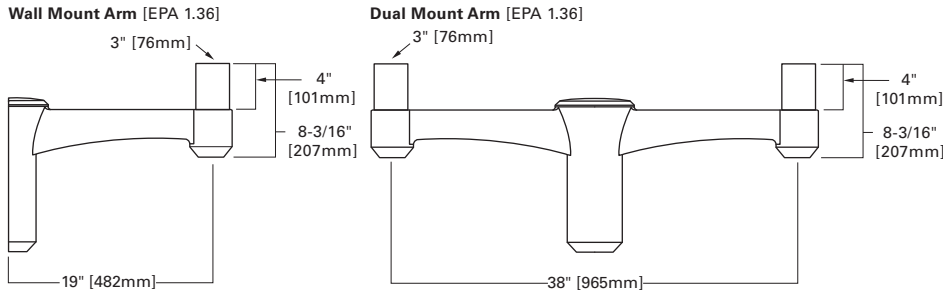
**EPA**

**Effective Projected Area: (Sq. Ft.)**  
1.1

**SHIPPING DATA Approximate**  
Net Weight (lbs.): 50



ACCESSORIES



ORDERING INFORMATION

Sample Number: MSA-400-MH-MT-3S-FG-BK-L

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**Product Family**  
MSA=MESA  
(Slipfits over 3" O.D. tenon)

**Lamp Wattage**  
MP  
50=50W  
70=70W  
100=100W  
150=150W  
175=175W  
250=250W  
320=320W  
350=350W  
400=400W<sup>2</sup>  
MH<sup>3</sup>  
175=175W  
250=250W  
400=400W<sup>2</sup>  
HPS  
50=50W  
70=70W  
100=100W  
150=150W  
250=250W  
400=400W<sup>2</sup>  
**Compact Fluorescent**  
42=42W<sup>4</sup>  
57=57W<sup>4, 5</sup>  
84=(2) 42W<sup>6</sup>  
114=(2) 57W<sup>6</sup>

**Lamp Type**  
MP=Pulse Start Metal Halide  
MH=Metal Halide  
HPS=High Pressure Sodium  
CF=Compact Fluorescent<sup>7</sup>  
**Voltage**<sup>8</sup>  
120=120V  
208=208V  
240=240V  
277=277V  
347=347V  
480=480V  
DT=Dual-Tap wired 277V<sup>9</sup>  
MT=Multi-Tap wired 277V<sup>10</sup>  
TT=Triple-Tap wired 347V<sup>11</sup>  
UNV=120-277V Universal Electronic Ballast

**Optical System**  
2S=Type II  
3S=Type III  
4S=Type IV  
5S=Type V  
SL=Forward Throw w/ Spill Light Eliminator

**Lens Type**  
FG=Flat Glass  
FR=Frosted Flat Glass  
SG=Sag Glass  
FRS=Frosted Sag Glass  
VS=Polycarbonate Vandal Shield<sup>12</sup>

**Color**<sup>13</sup>  
BK=Black  
AP=Grey  
BZ=Bronze  
WH=White  
DP=Dark Platinum  
GM=Graphite Metallic  
GN=Hartford Green

**Accessories**<sup>19</sup>  
VA6028-XX=Dual Mount Arm (EPA 1.36)  
VA6029-XX=Wall Mount Arm  
OA/RA1016=NEMA Photocontrol - Multi-Tap  
OA/RA1027=NEMA Photocontrol - 480V  
OA/RA1201=NEMA Photocontrol - 347V

**Options**<sup>14</sup>  
F=Single Fuse (120, 277 or 347V) Specify Voltage  
FF=Double Fuse (208, 240 or 480V) Specify Voltage  
Q=Quartz Restrike<sup>15</sup>  
EM=Quartz Restrike w/ Time Delay (Also Strikes at <sup>15</sup> Cold Start)  
EM/SC=Quartz Emergency Separate Circuit<sup>15</sup>  
42CF/EM=Emergency Battery Backup<sup>16</sup>  
R=NEMA Twistlock Photocell Receptacle  
PC=Button Type Photocontrol (Specify Voltage)  
DS=Dual Fluorescent Switching Control<sup>17</sup>  
HS=House Side Shield<sup>18</sup>  
L=Lamp Included

- Notes: 1 Standard with mogul-base socket for HPS, MH and 175-400W MP. Standard with medium-base socket for MP lamps 150W and below.
- 2 400W MP and MH requires reduced envelope ED28 lamp.
- 3 MH products available for non-U.S. markets only.
- 4 Available in Type 3S, 4S, and 5S distributions only.
- 5 Nominal M.O.L lamp length of 57W CFL not to exceed 7".
- 6 Dual Compact Fluorescent lamp options available in Type 2S with 84 and 114W. Type 3S available in 84W only.
- 7 CF ballasts are 120 through 277V. Specify with UNV voltage designation.
- 8 Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information.
- 9 Dual-tap is 120/277V wired 277V.
- 10 Multi-tap is 120/208/240/277V wired 277V.
- 11 Triple-tap is 120/277/347V wired 347V.
- 12 Maximum wattage of 250W HID.
- 13 Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
- 14 Add as suffix in the order shown.
- 15 Quartz options not available with SL optic.
- 16 Battery backup provides 90 minutes of supplemental light at 60% of initial rated lamp lumens. Type 3S, 4S, 5S optics only. Must specify 42W Compact Fluorescent lamp.
- 17 Dual switching requires dual 42W or dual 57W Compact Fluorescent lamps. Allows independent switching control of each lamp through use of two (2) electronic ballasts. Allows 50% power reduction when dual ballasts are independently wired and controlled.
- 18 House side shield not available on 5S and SL optics.
- 19 Order separately, replace XX with color suffix.

**DESCRIPTION**

ENTRI Series' family of modular faceplate designs provide a tasteful architectural statement equally suitable for indoor and outdoor environments. Available luminous faceplate window adds a signature look, while affording custom color capability.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>S5</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Construction**

**HOUSING:** One piece die-cast aluminum construction for precise tolerance control and repeatability in manufacturing. Accommodates either up or down mounting configurations with no modifications. Downlight and uplight lens' are impact resistant 5/32" thick tempered clear or frosted flat glass, sealed to the housing with high strength VHB adhesive tape and a continuous silicone bead gasket. Silicone wireway plug on housing back wall seals incoming electrical leads to prevent moisture and dust entry. **FACEPLATE:** One piece die-cast aluminum faceplate utilizes a continuous silicone gasket to seal securely to housing. Side hinged faceplate swings open via release of one (1) flush mount die-cast aluminum latch on housing side panel. Available luminous glass insert is .16" thick frosted glass, secured to back of faceplate with a continuous EPDM gasket. Available colored gel film secures behind glass.

**Electrical**

**ELECTRICAL COMPONENTS:** Ballast and related electrical componentry are heat sunk to the housing for cooler operation and prolonged life.

**Optical**

**OPTICAL SYSTEM:** Choice of ten (10) high efficiency optical systems constructed of premium 95% reflective anodized aluminum sheet, or bright specular anodized polished spun aluminum. Available distributions include Type III, Type III with 10% secondary glow, Type III with pencil secondary, Forward Throw, Forward Throw with 10% secondary glow, Forward Throw with pencil secondary, FX grazing optic, FXF 50% up/50% down grazing optic, Tight Spot, and 50% up/50% down Tight Spot. Optical segments are rigidly mounted inside a heavy wall aluminum housing for superior protection. All segment faces are clean of rivet heads, tabs, or other means of attachment which may cause streaking in the light distribution. All reflector modules feature quick disconnect wiring plugs. T6 Pulse Start Metal Halide lamps feature G12 lampholders, White SonTM High Pressure Sodium lamp features a GX12 lampholder, Quartz Halogen lamps feature mini-can screw based lampholders, and Compact Fluorescent lamps feature GX24q-(3,4,5) 4-pin lampholders.

**Mounting**

Standard zinc plated attachment plate mounts directly to 4" J-Box. Fixture slides over mounting plate and is secured with two (2) concealed stainless steel fasteners. Mounting plate features one-piece, EPDM gasket on back side of plate to firmly seal fixture to wall surface, forbidding entry of moisture and particulates. Optional mounting arrangements utilize a die-cast aluminum adapter box to allow for surface conduit wiring, quartz lamp options, and emergency battery pack capability.

**Finish**

Housing finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.



**ENV  
ENTRI  
ROUND  
REVEALS**

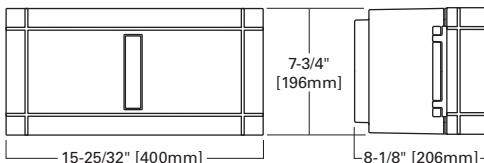
- 26 - 250W**
- Pulse Start Metal Halide**
- Whiteson High Pressure Sodium**
- Compact Fluorescent**
- Quartz Halogen**

**ARCHITECTURAL  
WALL LUMINAIRE**



NOTE: In downlight only configurations with no faceplate window.

**DIMENSIONS**



**WATTAGE TABLE**

Lamp Type	Wattage
Pulse Start Metal Halide (MP)	39, 70, 100, 150W
WhiteSON HPS (WS)	100W
Compact Fluorescent (CF)	(1) 26, (2) 26, (1) 32, (2) 32, (1) 42, (2) 42, (1) 57W
Quartz Halogen (HL)	100, 150, 250W

**CERTIFICATION DATA**

- IP66 Rated
- U.L. 1598 Listed
- CSA Listed
- 40°C Ambient Temperature Rating
- ISO 9001
- Full Cutoff (In downlight only configurations with no faceplate window)

**SHIPPING DATA**

- (Approximate)**
- Net Weight (lbs.): 13
- Volume (cu. ft): 4.5



ORDERING INFORMATION

Sample Number: ENV-150-MH-120-EB-3S-BK-LG-L

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**Product Family**  
ENV=ENTRI Round Reveals

**Lamp Wattage**

**MP**<sup>1</sup>  
39=39W  
70=70W  
100=100W  
150=150W  
**WS**<sup>1</sup>  
100=100W  
**Compact Fluorescent**<sup>2</sup>  
26=26W  
32=32W  
42=42W  
52=(2) 26W<sup>3</sup>  
57=57W<sup>4</sup>  
64=(2) 32W<sup>3</sup>  
84=(2) 42W<sup>3</sup>  
**Halogen**<sup>5</sup>  
100=100W  
150=150W  
250=250W

**Lamp Type**

**MP**=Pulse Start Metal Halide  
**WS**=WhiteSON High<sup>6</sup> Pressure Sodium  
**CF**=Compact Fluorescent<sup>7</sup>  
**HL**=Quartz Halogen

**Voltage**<sup>8</sup>

120=120V  
208=208V  
240=240V  
277=277V  
347=347V  
480=480V  
**DT**=Dual-Tap<sup>9</sup> wired 277V  
**MT**=Multi-Tap<sup>10</sup> wired 277V  
**TT**=Triple-Tap<sup>11</sup> wired 347V  
**UNV**=120-277V Universal Electronic Ballast

**Ballast**

**MB**=Magnetic Ballast  
**EB**=Electronic<sup>12</sup> Ballast

**Optical System**

**Downlight or Uplight (HID or Halogen)**  
**3S**=Type III  
**FT**=Forward Throw  
**FX**=Wall Grazing Optic  
**TS**=Tight Spot  
**Downlight and Uplight (HID and Halogen)**  
**3SG**=Type III, 90% Main/10% Secondary Glow  
**3SP**=Type III with Pencil Secondary  
**FTG**=Forward Throw, 90% Main/10% Secondary Glow  
**FTP**=Forward Throw with Pencil Secondary  
**FXF**=Wall Grazing Optic, 50% Up/50% Down  
**TSF**=Tight Spot, 50% Up/50% Down  
**Compact Fluorescent**  
**CFG**=90% Main + 10% Secondary Glow  
**CFM**=100% Main, Up or Downlighting

**Color**<sup>13</sup>

**BK**=Black  
**AP**=Grey  
**BZ**=Bronze  
**WH**=White  
**DP**=Dark Platinum  
**GM**=Graphite Metallic

**Optional Luminous Faceplate Insert**

**LG**=Luminous Glass Insert  
**LGO**=Luminous Glass Insert w/ Warm Orange Gel  
**LGR**=Luminous Glass Insert w/ Red Gel  
**LGB**=Luminous Glass Insert w/ Bright Blue Gel  
**LGG**=Luminous Glass Insert w/ Deep Green Gel

**Options**<sup>14</sup>

**F**=Single Fuse (120, 277 or 347V) Specify Voltage  
**FF**=Double Fuse (208, 240 or 480V) Specify Voltage  
**DSAB**=Dual Fluorescent Switching Control Adapter Box<sup>15, 16</sup>  
**QAB**=Quartz Restrike Adapter Box<sup>16</sup>  
**EMAB**=Quartz Restrike w/ Delay Adapter Box (Also<sup>16</sup> Strikes at Cold Start)  
**EM/SCAB**=Quartz Emergency Separate Circuit Adapter<sup>16</sup> Box  
**CF/EMAB**=Emergency Battery Backup Adapter Box<sup>16, 17</sup>  
**PC**=Button Type Photocontrol (Specify Voltage)  
**WG**=Wire Guard<sup>18</sup>  
**FRM**=Frosted Main Flat Glass  
**FRS**=Frosted Secondary Flat Glass<sup>19</sup>  
**L**=Lamp Included (Standard for all Halogen lamps)

**Accessories**<sup>20</sup>

**VA2001-XX**=Thru-way<sup>16</sup> Box  
**VA2002**=Wire Guard Kit

- Notes:**
- All MP lamps are T6 envelope with G12 lamp base. All HPS lamps are T6 envelope with GX12 lamp base.
  - All 26/32/42/57W CF lamps feature a 4-pin lamp base. Available in CFM and CFG distributions only.
  - Dual compact fluorescent lamps.
  - Nominal M.O.L lamp length of 57W CFL not to exceed 7".
  - All Halogen lamps are T4 envelope with mini-can base.
  - WhiteSON HPS lamp available in 100W only. Requires electronic ballast. 120/277V only. Requires use of VA2001 accessory Thru-way Box.
  - CF ballasts are 120 through 277V. Specify with UNV voltage designation.
  - Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information.
  - Dual-tap is 120/277V wired 277V.
  - Multi-tap is 120/208/240/277V wired 277V.
  - Triple-tap is 120/277/347V wired 347V.
  - 120 through 277V only. Electronic ballast standard with all CF lamps. EB available with 39/70/100/150W MP lamps. 150W requires and is supplied with VA2001 Thru-way Box. Not available with QAB or EMAB options.
  - Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
  - Add as suffix in the order shown.
  - Dual switching requires dual 26, 32 or 42W Compact Fluorescent lamps. Allows independent switching control of each lamp through use of two (2) electronic ballasts. Allows 50% power reduction when dual ballasts are independently wired and controlled.
  - VA2001 and thru-way adaptor box options to be mounted facing downward only. Cannot be used for primary "uplight only" applications.
  - CF lamps only. Battery backup provides 90 minutes of supplemental light, minimum operating temperature of 32°F (0°C), 42W maximum.
  - For use in down lighting applications only.
  - Frosted secondary lens provided standard on 3SG, FTG, and CFG distributions.
  - Order separately, replace XX with color suffix.

**DESCRIPTION**

ENTRI Series' family of modular faceplate designs provide a tasteful architectural statement equally suitable for indoor and outdoor environments. Available luminous faceplate window adds a signature look, while affording custom color capability.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>S5a</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Construction**

**HOUSING:** One piece die-cast aluminum construction for precise tolerance control and repeatability in manufacturing. Accommodates either up or down mounting configurations with no modifications. Downlight and uplight lens' are impact resistant 5/32" thick tempered clear or frosted flat glass, sealed to the housing with high strength VHB adhesive tape and a continuous silicone bead gasket. Silicone wireway plug on housing back wall seals incoming electrical leads to prevent moisture and dust entry. **FACEPLATE:** One piece die-cast aluminum faceplate utilizes a continuous silicone gasket to seal securely to housing. Side hinged faceplate swings open via release of one (1) flush mount die-cast aluminum latch on housing side panel. Available luminous glass insert is .16" thick frosted glass, secured to back of faceplate with a continuous EPDM gasket. Available colored gel film secures behind glass.

**Electrical**

**ELECTRICAL COMPONENTS:** Ballast and related electrical componentry are heat sunk to the housing for cooler operation and prolonged life.

**Optical**

**OPTICAL SYSTEM:** Choice of ten (10) high efficiency optical systems constructed of premium 95% reflective anodized aluminum sheet, or bright specular anodized polished spun aluminum. Available distributions include Type III, Type III with 10% secondary glow, Type III with pencil secondary, Forward Throw, Forward Throw with 10% secondary glow, Forward Throw with pencil secondary, FX grazing optic, FXF 50% up/50% down grazing optic, Tight Spot, and 50% up/50% down Tight Spot. Optical segments are rigidly mounted inside a heavy wall aluminum housing for superior protection. All segment faces are clean of rivet heads, tabs, or other means of attachment which may cause streaking in the light distribution. All reflector modules feature quick disconnect wiring plugs. T6 Pulse Start Metal Halide lamps feature G12 lampholders, White SonTM High Pressure Sodium lamp features a GX12 lampholder, Quartz Halogen lamps feature mini-can screw based lampholders, and Compact Fluorescent lamps feature GX24q-(3,4,5) 4-pin lampholders.

**Mounting**

Standard zinc plated attachment plate mounts directly to 4" J-Box. Fixture slides over mounting plate and is secured with two (2) concealed stainless steel fasteners. Mounting plate features one-piece, EPDM gasket on back side of plate to firmly seal fixture to wall surface, forbidding entry of moisture and particulates. Optional mounting arrangements utilize a die-cast aluminum adapter box to allow for surface conduit wiring, quartz lamp options, and emergency battery pack capability.

**Finish**

Housing finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.



**ENV  
ENTRI  
ROUND  
REVEALS**

**26 - 250W**

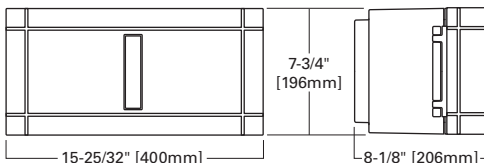
- Pulse Start Metal Halide**
- Whiteson High Pressure Sodium**
- Compact Fluorescent**
- Quartz Halogen**

**ARCHITECTURAL  
WALL LUMINAIRE**



NOTE: In downlight only configurations with no faceplate window.

**DIMENSIONS**



**WATTAGE TABLE**

Lamp Type	Wattage
Pulse Start Metal Halide (MP)	39, 70, 100, 150W
WhiteSON HPS (WS)	100W
Compact Fluorescent (CF)	(1) 26, (2) 26, (1) 32, (2) 32, (1) 42, (2) 42, (1) 57W
Quartz Halogen (HL)	100, 150, 250W

**CERTIFICATION DATA**

- IP66 Rated
- U.L. 1598 Listed
- CSA Listed
- 40°C Ambient Temperature Rating
- ISO 9001
- Full Cutoff (In downlight only configurations with no faceplate window)

**SHIPPING DATA**

- (Approximate)**
- Net Weight (lbs.): 13
- Volume (cu. ft): 4.5



ORDERING INFORMATION

Sample Number: ENV-150-MH-120-EB-3S-BK-LG-L

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**Product Family**  
ENV=ENTRI Round Reveals

**Lamp Wattage**

- MP**<sup>1</sup>  
39=39W  
70=70W  
100=100W  
150=150W  
**WS**<sup>1</sup>  
100=100W  
**Compact Fluorescent**<sup>2</sup>  
26=26W  
32=32W  
42=42W  
52=(2) 26W<sup>3</sup>  
57=57W<sup>4</sup>  
64=(2) 32W<sup>3</sup>  
84=(2) 42W<sup>3</sup>  
**Halogen**<sup>5</sup>  
100=100W  
150=150W  
250=250W

**Lamp Type**

- MP**=Pulse Start Metal Halide  
**WS**=WhiteSON High<sup>6</sup> Pressure Sodium  
**CF**=Compact Fluorescent<sup>7</sup>  
**HL**=Quartz Halogen

**Voltage**<sup>8</sup>

- 120=120V  
208=208V  
240=240V  
277=277V  
347=347V  
480=480V  
**DT**=Dual-Tap<sup>9</sup> wired 277V  
**MT**=Multi-Tap<sup>10</sup> wired 277V  
**TT**=Triple-Tap<sup>11</sup> wired 347V  
**UNV**=120-277V Universal Electronic Ballast

**Ballast**

- MB**=Magnetic Ballast  
**EB**=Electronic<sup>12</sup> Ballast

**Optical System**

- Downlight or Uplight (HID or Halogen)**  
**3S**=Type III  
**FT**=Forward Throw  
**FX**=Wall Grazing Optic  
**TS**=Tight Spot  
**Downlight and Uplight (HID and Halogen)**  
**3SG**=Type III, 90% Main/10% Secondary Glow  
**3SP**=Type III with Pencil Secondary  
**FTG**=Forward Throw, 90% Main/10% Secondary Glow  
**FTP**=Forward Throw with Pencil Secondary  
**FXF**=Wall Grazing Optic, 50% Up/50% Down  
**TSF**=Tight Spot, 50% Up/50% Down  
**Compact Fluorescent**  
**CFG**=90% Main + 10% Secondary Glow  
**CFM**=100% Main, Up or Downlighting

**Color**<sup>13</sup>

- BK**=Black  
**AP**=Grey  
**BZ**=Bronze  
**WH**=White  
**DP**=Dark Platinum  
**GM**=Graphite Metallic

**Optional Luminous Faceplate Insert**

- LG**=Luminous Glass Insert  
**LGO**=Luminous Glass Insert w/ Warm Orange Gel  
**LGR**=Luminous Glass Insert w/ Red Gel  
**LGB**=Luminous Glass Insert w/ Bright Blue Gel  
**LGG**=Luminous Glass Insert w/ Deep Green Gel

**Options**<sup>14</sup>

- F**=Single Fuse (120, 277 or 347V) Specify Voltage  
**FF**=Double Fuse (208, 240 or 480V) Specify Voltage  
**DSAB**=Dual Fluorescent Switching Control Adapter Box<sup>15, 16</sup>  
**QAB**=Quartz Restrike Adapter Box<sup>16</sup>  
**EMAB**=Quartz Restrike w/ Delay Adapter Box (Also<sup>16</sup> Strikes at Cold Start)  
**EM/SCAB**=Quartz Emergency Separate Circuit Adapter<sup>16</sup> Box  
**CF/EMAB**=Emergency Battery Backup Adapter Box<sup>16, 17</sup>  
**PC**=Button Type Photocontrol (Specify Voltage)  
**WG**=Wire Guard<sup>18</sup>  
**FRM**=Frosted Main Flat Glass  
**FRS**=Frosted Secondary Flat Glass<sup>19</sup>  
**L**=Lamp Included (Standard for all Halogen lamps)

**Accessories**<sup>20</sup>

- VA2001-XX**=Thru-way<sup>16</sup> Box  
**VA2002**=Wire Guard Kit

- Notes:**
- All MP lamps are T6 envelope with G12 lamp base. All HPS lamps are T6 envelope with GX12 lamp base.
  - All 26/32/42/57W CF lamps feature a 4-pin lamp base. Available in CFM and CFG distributions only.
  - Dual compact fluorescent lamps.
  - Nominal M.O.L lamp length of 57W CFL not to exceed 7".
  - All Halogen lamps are T4 envelope with mini-can base.
  - WhiteSON HPS lamp available in 100W only. Requires electronic ballast. 120/277V only. Requires use of VA2001 accessory Thru-way Box.
  - CF ballasts are 120 through 277V. Specify with UNV voltage designation.
  - Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information.
  - Dual-tap is 120/277V wired 277V.
  - Multi-tap is 120/208/240/277V wired 277V.
  - Triple-tap is 120/277/347V wired 347V.
  - 120 through 277V only. Electronic ballast standard with all CF lamps. EB available with 39/70/100/150W MP lamps. 150W requires and is supplied with VA2001 Thru-way Box. Not available with QAB or EMAB options.
  - Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
  - Add as suffix in the order shown.
  - Dual switching requires dual 26, 32 or 42W Compact Fluorescent lamps. Allows independent switching control of each lamp through use of two (2) electronic ballasts. Allows 50% power reduction when dual ballasts are independently wired and controlled.
  - VA2001 and thru-way adaptor box options to be mounted facing downward only. Cannot be used for primary "uplight only" applications.
  - CF lamps only. Battery backup provides 90 minutes of supplemental light, minimum operating temperature of 32°F (0°C), 42W maximum.
  - For use in down lighting applications only.
  - Frosted secondary lens provided standard on 3SG, FTG, and CFG distributions.
  - Order separately, replace XX with color suffix.



**DESCRIPTION**

VISION FLOOD'S cylindrical form blends effortlessly to architectural and landscape environments. Available in wattages up to 1000 watt Metal Halide and Pulse Start Metal Halide, and in two (2) housing sizes, VISION FLOOD offers properly scaled solutions for any floodlighting application.

<b>Catalog #</b>		<b>Type</b>
<b>Project</b>		<b>S6</b>
<b>Comments</b>		<b>Date</b>
<b>Prepared by</b>		

**SPECIFICATION FEATURES**

**Construction**

**HOUSING:** One-piece die-cast aluminum housing maintains a nominal .125" thickness to endure the toughest environments while maintaining precise tolerance control. **DOOR:** Die-cast aluminum door maintains a nominal .125" thickness and features concealed hinging to the housing. Door is secured with four (4) tamper resistant recessed stainless steel allen head fasteners. Door frame features an integral accessory channel for the mounting of optional light control accessories. Doorframe seals to housing with a continuous extruded silicone gasket. Lens is impact resistant .180" thick tempered clear flat glass, sealed to the door with a one-piece silicone gasket. **KNUCKLE:** Heavy-duty die-cast aluminum knuckle utilizes a taper-lock adjustment mechanism for both solid engagement and infinite aiming adjustment. Knuckle

adjustment is made via one (1) captive stainless steel allen head fastener consistent with doorframe fasteners. Tested to sustain 3G of vibration without losing aiming position. VFS knuckle features a 3/4" NPT nipple on bottom surface for rigid attachment to available mounting accessories. Optional slipfitter mount available for VFS.

**Electrical**

**ELECTRICAL COMPONENTS:** High Power Factor (HPF) ballast components are strategically located and heat sunk to the housing for cooler operation and longer life. The VFS housing is rated for 40 degrees C (104 degrees F) ambient environments.

**Optical**

**OPTICAL ASSEMBLY:** Choice of six (6) high efficiency optical systems constructed of premium 95% reflective anodized aluminum sheet, or bright specular anodized

polished spun aluminum. Available distributions include Narrow Spot, Narrow Flood, Medium Flood, Wide Flood, Horizontal Spot, and Vertical Flood. All reflector modules feature toolless removal, quick disconnect wire connections, and are field interchangeable. Small housing (VFS) optics feature medium-base lampholders.

**Finish**

Housing and arm finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.

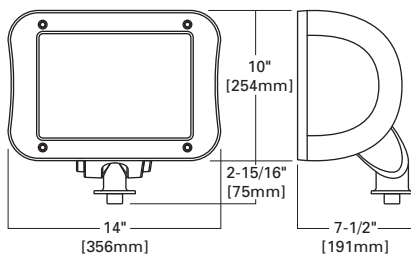


**VFS  
VISION FLOOD  
SMALL**

**50 - 175W**  
Pulse Start Metal Halide  
Metal Halide  
High Pressure Sodium

**ARCHITECTURAL  
FLOOD LUMINAIRE**

**DIMENSIONS**



**WATTAGE TABLE**

Lamp Type	Wattage
Pulse Start Metal Halide (MP)	50, 70, 100, 150W
High Pressure Sodium (HPS)	50, 70, 100, 150W
Metal Halide (MH)	175W

**CERTIFICATION DATA**

IP65 Rated  
U.L. 1598 Listed  
3G Vibration Tested  
CSA Listed  
40°C Ambient Temperature Rating  
ISO 9001

**EPA**

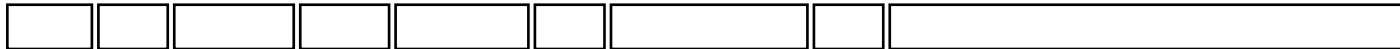
**Effective Projected Area:  
(Sq. Ft.)**  
1.19

**SHIPPING DATA  
(Approximate)**

Net Weight (lbs.): 37

ORDERING INFORMATION

Sample Number: VFS-K-150-MP-120-NF-WH



**Product Family**  
VFS=Vision Flood Small

**Mounting Type**  
K=Knuckle

**Lamp Wattage** <sup>1</sup>

**MP**  
50=50W  
70=70W  
100=100W  
150= 150W  
**MH** <sup>2</sup>  
175= 175W  
**HPS**  
50= 50W  
70= 70W  
100= 100W  
150= 150W

**Lamp Type**

**MP**: Pulse Start Metal Halide  
**MH**: Metal Halide  
**HPS**: High Pressure Sodium

**Voltage** <sup>3</sup>

120=120V  
208=208V  
240=240V  
277=277V  
347= 347V  
480= 480V  
**DT**: Dual-Tap wired 277V<sup>4</sup>  
**MT**: Multi-Tap wired 277V<sup>5</sup>  
**TT**: Triple-Tap wired 347V<sup>6</sup>

**Optical System**

**NS**: Narrow Spot  
**NF**: Narrow Flood  
**MF**: Medium Flood  
**WF**: Wide Flood  
**VF**: Vertical Flood  
**HS**: Horizontal Spot

**Color** <sup>7</sup>

**BK**=Black  
**AP**=Grey  
**BZ**=Bronze  
**WH**=White  
**DP**: Dark Platinum  
**GM**: Graphite Metallic  
**VR**: Verde Green

**Options** <sup>8</sup>

**F**: Single Fuse (120, 277 or 347V)  
Specify Voltage  
**FF**: Double Fuse (208, 240 or 480V)  
Specify Voltage  
**PC**: Button Type Photocontrol  
(Specify Voltage)  
**L**: Lamp Included

**Accessories** <sup>9</sup>

**JB-XX**=Architectural J-Box with two 3/4" NPT Entries  
**SM-XX**=Stanchion Mount  
**ST-XX**=Stanchion Mount Tenon  
**WM-XX**=Wall Mount  
**WMA-XX**: Wall Mount Arm  
**WMT-XX**: Wall Mount Arm Tenon Mount  
**TMA-XX**: Twin Mount Arm - EPA 0.35  
**TMT-XX**: Twin Mount Arm Tenon Mount - EPA 0.42  
**SMT-XX**: Surface Mount Tenon  
**SF-XX**: Slipfitter  
**PM1-XX**: Post Mount Extension Single - EPA 0.12  
**PM2-XX**: Post Mount Extension Double - EPA 0.12  
**VFS-CFR-XX**: Color Filter Adapter with Red Gel  
**VFS-CFB-XX**: Color Filter Adapter with Bright Blue Gel  
**VFS-CFG-XX**: Color Filter Adapter with Deep Green Gel  
**VFS-CFO-XX**: Color Filter Adapter with Warm Orange Gel  
**VFS-BD-XX**: Barn Doors - EPA 1.01  
**VFS-TV-XX**: Top Visor - EPA 0.6  
**VFS-VS**: Vandal Shield  
**VFS-GL1**: External Grid Louver (NS and NF Optics Only)<sup>10</sup>  
**VFS-GL2**=External Grid Louver (MF, WF, VF and HS optics<sup>10</sup> only)

- Notes:**
- 1 All HID lamps are medium-base.
  - 2 MH products available for non-U.S. markets only.
  - 3 Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information.
  - 4 Dual-tap is 120/277V wired 277V.
  - 5 Multi-tap is 120/208/240/277V wired 277V.
  - 6 Triple-tap is 120/277/347V wired 347V.
  - 7 Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
  - 8 Add as suffix in the order shown.
  - 9 Order separately, replace XX with color suffix.
  - 10 Standard color is black powder coat.



## DESCRIPTION

VISION FLOOD'S cylindrical form blends effortlessly to architectural and landscape environments. Available in wattages up to 1000 watt Metal Halide and Pulse Start Metal Halide, and in two (2) housing sizes, VISION FLOOD offers properly scaled solutions for any floodlighting application.

Catalog #		Type
Project		S7
Comments		Date
Prepared by		

## SPECIFICATION FEATURES

### Construction

**HOUSING:** One-piece die-cast aluminum housing maintains a nominal .125" thickness to endure the toughest environments while maintaining precise tolerance control. **DOOR:** Die-cast aluminum door maintains a nominal .125" thickness and features concealed hinging to the housing. Door is secured with four (4) tamper resistant recessed stainless steel allen head fasteners. Door frame features an integral accessory channel for the mounting of optional light control accessories. Doorframe seals to housing with a continuous extruded silicone gasket. Lens is impact resistant .180" thick tempered clear flat glass, sealed to the door with a one-piece silicone gasket. **KNUCKLE:** Heavy-duty die-cast aluminum knuckle utilizes a taper-lock adjustment mechanism for both solid engagement and infinite aiming adjustment. Knuckle

adjustment is made via one (1) captive stainless steel allen head fastener consistent with doorframe fasteners. Tested to sustain 3G of vibration without losing aiming position. VFS knuckle features a 3/4" NPT nipple on bottom surface for rigid attachment to available mounting accessories. Optional slipfitter mount available for VFS.

### Electrical

**ELECTRICAL COMPONENTS:** High Power Factor (HPF) ballast components are strategically located and heat sunk to the housing for cooler operation and longer life. The VFS housing is rated for 40 degrees C (104 degrees F) ambient environments.

### Optical

**OPTICAL ASSEMBLY:** Choice of six (6) high efficiency optical systems constructed of premium 95% reflective anodized aluminum sheet, or bright specular anodized

polished spun aluminum. Available distributions include Narrow Spot, Narrow Flood, Medium Flood, Wide Flood, Horizontal Spot, and Vertical Flood. All reflector modules feature toolless removal, quick disconnect wire connections, and are field interchangeable. Small housing (VFS) optics feature medium-base lampholders.

### Finish

Housing and arm finished in a 5 stage premium TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, grey, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.

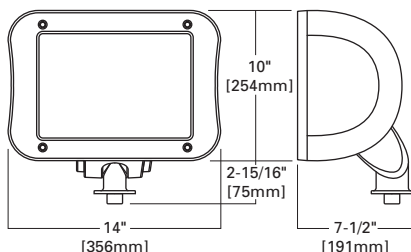


## VFS VISION FLOOD SMALL

50 - 175W  
Pulse Start Metal Halide  
Metal Halide  
High Pressure Sodium

ARCHITECTURAL  
FLOOD LUMINAIRE

## DIMENSIONS



## WATTAGE TABLE

Lamp Type	Wattage
Pulse Start Metal Halide (MP)	50, 70, 100, 150W
High Pressure Sodium (HPS)	50, 70, 100, 150W
Metal Halide (MH)	175W

## CERTIFICATION DATA

IP65 Rated  
U.L. 1598 Listed  
3G Vibration Tested  
CSA Listed  
40°C Ambient Temperature Rating  
ISO 9001

## EPA

**Effective Projected Area:**  
(Sq. Ft.)  
1.19

## SHIPPING DATA (Approximate)

Net Weight (lbs.): 37

## ORDERING INFORMATION

Sample Number: VFS-K-150-MP-120-NF-WH

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**Product Family**

VFS=Vision Flood Small

**Mounting Type**

K=Knuckle

**Lamp Wattage** <sup>1</sup>**MP**

50=50W  
70=70W  
100=100W  
150=150W  
MH <sup>2</sup>  
175=175W  
HPS  
50=50W  
70=70W  
100=100W  
150=150W

**Lamp Type**

MP: Pulse Start Metal Halide  
MH: Metal Halide  
HPS: High Pressure Sodium

**Voltage** <sup>3</sup>

120=120V  
208=208V  
240=240V  
277=277V  
347=347V  
480=480V  
DT: Dual-Tap wired 277V<sup>4</sup>  
MT: Multi-Tap wired 277V<sup>5</sup>  
TT: Triple-Tap wired 347V<sup>6</sup>

**Optical System**

NS: Narrow Spot  
NF: Narrow Flood  
MF: Medium Flood  
WF: Wide Flood  
VF: Vertical Flood  
HS: Horizontal Spot

**Color** <sup>7</sup>

BK=Black  
AP=Grey  
BZ=Bronze  
WH=White  
DP: Dark Platinum  
GM: Graphite Metallic  
VR: Verde Green

**Options** <sup>8</sup>

F: Single Fuse (120, 277 or 347V)  
Specify Voltage  
FF: Double Fuse (208, 240 or 480V)  
Specify Voltage  
PC: Button Type Photocontrol  
(Specify Voltage)  
L: Lamp Included

**Accessories** <sup>9</sup>

JB-XX=Architectural J-Box with two 3/4" NPT Entries  
SM-XX=Stanchion Mount  
ST-XX=Stanchion Mount Tenon  
WM-XX=Wall Mount  
WMA-XX: Wall Mount Arm  
WMT-XX: Wall Mount Arm Tenon Mount  
TMA-XX: Twin Mount Arm - EPA 0.35  
TMT-XX: Twin Mount Arm Tenon Mount - EPA 0.42  
SMT-XX: Surface Mount Tenon  
SF-XX: Slipfitter  
PM1-XX: Post Mount Extension Single - EPA 0.12  
PM2-XX: Post Mount Extension Double - EPA 0.12  
VFS-CFR-XX: Color Filter Adapter with Red Gel  
VFS-CFB-XX: Color Filter Adapter with Bright Blue Gel  
VFS-CFG-XX: Color Filter Adapter with Deep Green Gel  
VFS-CFO-XX: Color Filter Adapter with Warm Orange Gel  
VFS-BD-XX: Barn Doors - EPA 1.01  
VFS-TV-XX: Top Visor - EPA 0.6  
VFS-VS: Vandal Shield  
VFS-GL1: External Grid Louver (NS and NF Optics Only)<sup>10</sup>  
VFS-GL2: External Grid Louver (MF, WF, VF and HS optics<sup>10</sup> only)

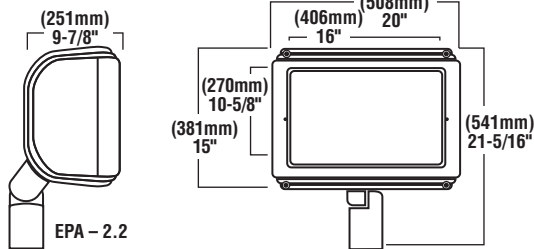
- Notes:**
- All HID lamps are medium-base.
  - MH products available for non-U.S. markets only.
  - Products also available in non-US voltages and 50Hz for international markets. Consult factory for availability and ordering information.
  - Dual-tap is 120/277V wired 277V.
  - Multi-tap is 120/208/240/277V wired 277V.
  - Triple-tap is 120/277/347V wired 347V.
  - Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
  - Add as suffix in the order shown.
  - Order separately, replace XX with color suffix.
  - Standard color is black powder coat.

**DORAL® - MEDIUM** (Various reflectors are protected by U.S. Patent No. 6,464,378.)

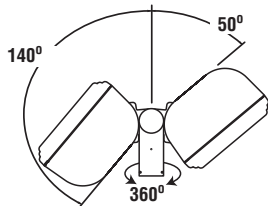
**ARCHITECTURAL FLOOD**



**DIMENSIONS**

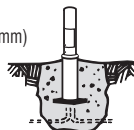


**AIMING RANGE**



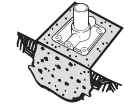
**MOUNTING BRACKETS**

**STANCHION MOUNT TENON (SMT):** 3" (76mm) O.D. x 250" (6mm) x 22.65" (575mm) cast aluminum with 2" (51mm) pipe tenon (2-3/8" OD x 4-3/4" min. length). Wiring and internal ground lug accessible through hand hole.

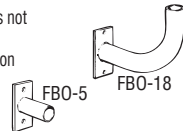


**PAD/WALL MOUNT (PWM)**

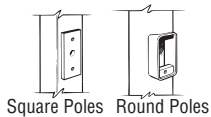
2" (51mm) pipe size aluminum tenon welded to a cast aluminum plate. Plate has four 1/2" (13mm) dia. mounting holes, and plate has two 1/2" (13mm) N.P.T. for conduit entry. Powder finish. Wall mount is single fixture only. Pad mount may use multiple mounting.



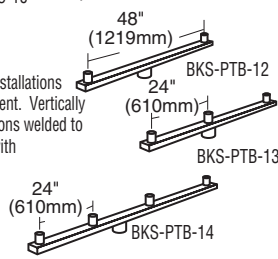
**FLOODLIGHTING BRACKETS FBO-5** For installations not requiring horizontal fixture adjustment. Horizontally mounted 2" (51mm) x 4-3/4" (120mm) pipe size tenon welded to a steel plate and secured by two bolts. **FBO-18** For installations requiring horizontal fixture adjustment. Vertically mounted 2" (51mm) x 17-1/2" (445mm) pipe size tenon welded to a steel plate and secured by two bolts.



**POLE PREPARATION** - Pole preparation "SF" or "DF" required when ordering FBO-5 or FBO-18 brackets. Note: FBO-5 and FBO-18 brackets can be ordered for round or square steel poles.



**TENON MOUNT BRACKET (PTB):** For installations requiring full horizontal fixture adjustment. Vertically mounted 2" (51mm) pipe size steel tenons welded to 2" (51mm) x 4" (102mm) steel arms, with removable end caps for wiring access. Arms are welded to a round slipfitter, compatible with stanchions or poles with 2" (51mm) pipe size tenons (2-3/8" O.D. x 4-3/4" min. length). Slipfitters are secured by 6 stainless steel set screws and one zinc plated through bolt.



**HOUSING** - One-piece cast aluminum in a multi-radiused rectangular shape with integral cooling ribs over the back. Internal concealed hinges permit full access to reflector area and housing interior. One-piece extruded silicone gasket between housing and door frame.

**DOOR FRAME** - One-piece cast aluminum door frame mates with housing to create multi-radiused shape. Door frame secures to housing by two internal (concealed) hinge brackets. 3/16" thick clear tempered glass lens seals to door frame by a one-piece silicone sponge gasket and stainless steel clips. Door frame secures to housing by four captive stainless steel recessed fasteners. Four holes provided for attachment of Glare Shield, Polycarbonate Shield, and Louver Shield.

**SOCKETS** - Porcelain mogul-base sockets. All sockets are pulse-rated.

**LIGHT SOURCES** - Pulse-Start Metal Halide, Pulse-Start Metal Halide Reduced Envelope, or High Pressure Sodium. Clear lamp is supplied as standard.

**BALLASTS/ELECTRICAL COMPONENTS** - Factory mounted in housing and prewired with leads extending through gasketing and into swivel mounting arm. UL listed components with high-power factor ballasts rated for -20° F starting. Optional photocell internally mounted in swivel mounting arm wiring access cover.

**REFLECTORS/DISTRIBUTION PATTERNS** - Doral Medium offers four reflector types: Horizontal Flood (HF), Medium Flood (MF), Vertical Flood (VF), and Spot Flood (SP). Reflectors are offered with highly reflective optical components. Photometric data is tested in accordance with IESNA guidelines.

**ADJUSTABLE SWIVEL MOUNTING ARM** - Two-piece cast aluminum ratcheting swivel design with external splice compartment supplied with aluminum access cover. Access cover permits field wiring while fixture is in position on pole or bracket. Internal toothed ratcheting system provides positive locking in a range of 190° with adjustment in increments of 5°. Swivel mounting arm accepts standard 2-3/8" O.D. x 4-3/4" minimum or 2-7/8" O.D. x 4-3/4" minimum tenon and is secured by four recessed allen set screws (through bolt optional by others). Swivel adjustment is made by concealed hex head pivot bolt. Mounting arm is internally and externally sealed by gasketing.

**BRACKETS** - Stanchion Mounts, Pad/Wall Mounts, or PTBs may be ordered with Doral Medium fixtures.

**FINISHES** - Each fixture is finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling, and is guaranteed for five full years. Standard colors include bronze, black, platinum plus, white, satin verde green, metallic silver, and graphite.

**PHOTOMETRICS** - Please visit our web site at [www.lsi-industries.com](http://www.lsi-industries.com) for detailed photometric data.



**ARRA**  
Funding Compliant



**SHIPPING WEIGHTS - Doral Medium**

Catalog Number	Est. Weight (kg/lbs.)	Length (mm/in.)	Width (mm/in.)	Height (mm/in.)
DRM	27/59	546/21.5	337/13.25	603/23.75



Project Name \_\_\_\_\_ Fixture Type \_\_\_\_\_  
Catalog # \_\_\_\_\_

**DORAL® - MEDIUM**

**ARCHITECTURAL FLOOD**



TYPICAL ORDER EXAMPLE: **DRM2 VF 400 HPS F MT BLK PCI120**

Luminaire Prefix	Distribution	Lamp Wattage	Light Source	Lens	Line Voltage	Luminaire Finish	Options
DRM2 – Doral Medium	HF – Horizontal Flood MF – Medium Flood VF – Vertical Flood SP – Spot	250 400	PSMU – Pulse-Start Metal Halide Universal 250 Watt PSMUR – Pulse-Start Metal Halide Reduced Envelope Universal 400 Watt HPS – High Pressure Sodium 250, 400 Watt	F – Flat Clear Tempered Glass	480 MT – Multi Tap TT – Tri-Tap	BRZ - Bronze BLK - Black PLP – Platinum Plus WHT - White SVG - Satin Verde Green GPT - Graphite MSV - Metallic Silver	PCI120 – Button-Type Photocell PCI208 – Button-Type Photocell <sup>1</sup> PCI240 – Button-Type Photocell <sup>1</sup> PCI277 – Button-Type Photocell <sup>1</sup> PCI347 – Button-Type Photocell SQT - Standby Quartz (Time Delay) <sup>2</sup> SQN - Standby Quartz (Non-Time Delay) <sup>2</sup> LL – Less Lamp
<p><b>MT – Multi Tap</b> consists of 120V, 208V, 240V and 277V and is prepared for highest voltage. Alternate voltages will require field adjustment.</p> <p><b>TT – Tri-Tap</b> consists of 120V, 277V and 347V and is shipped standard for Canadian applications and is prepared for highest voltage. Alternate voltages will require field adjustment.</p>					<p><b>Consult Factory for International Voltages and Light Sources</b></p>		

**FOOTNOTES:**

- 1- Photocells on 208V, 240V and 277V fixtures are wired for 277V operation. 208V or 240V photocells will require field re-wiring.
- 2- SQN and SQT options available with HF or VF distribution only.

**BRACKET ORDERING INFORMATION**

Bracket Designation	Bracket Type	Bracket Configuration	Length	Bracket Finish	Options	EPA Values*
BKA – Bracket Aluminum	DRM2 – Doral Medium	SMT – Stanchion Mount Tenon	23"	BRZ – Bronze BLK – Black PLP – Platinum Plus BUF – Buff WHT – White GPT – Graphite SVG – Satin Verde Green MSV – Metallic Silver	None	
		PWM – Pad/Wall Mount	6"			
BKS – Bracket Steel	—	FBO – Flood Bolt-on	5" 18"			0.1 0.6 1.8 1.8 2.5
		PTB-12 – Pole Top Bracket	48"			
		PTB-13 – Pole Top Bracket	48"			
		PTB-14 – Pole Top Bracket	72"			

TYPICAL ORDER EXAMPLE: **BKA DRM2 SMT 23 BLK**

**Notes:**

PTB brackets split 2-3/8" OD tenon. FBO brackets are available on steel round and square poles. FBO brackets require pole preparation and must be ordered with "SF" or "DF" pole option.

\*The bracket EPA should be added to the fixture EPA when selecting the proper pole.

**ACCESSORY ORDERING INFORMATION**

(Accessories are field installed)

Description	Order Number	Description	Order Number
BD – Barn Doors	90849CLR	FK120 - Single Fusing	FK120++
GS – Glare Shield	90850CLR	FK277 - Single Fusing	FK277++
PS – Polycarbonate Shield (Clear only)	90852	DFK208,240 - Double Fusing	DFK208,240++
LS – Louver Shield (Black only)	90853+	DFK480 - Double Fusing	DFK480++
		FK347 - Single Fusing	FK347++

++ Fusing to be installed in a compatible junction box (supplied by contractor), pole or stanchion mounting bracket.

BARN DOORS (BD)- Extruded aluminum doors with anti-reflection baffles. Each door hinged with a stainless steel clip – locks by a mounting screw. Doors are individually removable. Assembly mounts to die-cast door frame holes. **Caution:** Not recommended for ground-mounted fixtures in vandal-prone areas. Available in standard finishes.

GLARE SHIELD (GS)- Formed 1/16" thick aluminum. Mounts to cast door frame holes and may be used with Polycarbonate Shield option.

POLYCARBONATE SHIELD (PS) - 1/8" clear convex, U.V. stabilized, formed polycarbonate. Mounts to cast door frame holes. May be used with Glare Shield. **Caution:** Use only when vandalism is anticipated. Useful life is limited by U.V. discoloration from sunlight, HPS or MH lamps.

LOUVER SHIELD (LS) - Formed 1/16" thick aluminum with black finish. Mounts to cast door frame holes. Provides glare control. Available on Medium Flood and Spot distribution only.

Recessed wall luminaires with asymmetrical distribution

**Housing:** Die-cast aluminum with integral wiring compartment.

**Enclosure:** One piece die-cast aluminum faceplate with stepped baffle, 1/4" thick, clear tempered glass. Faceplate is secured by four (4) flush socket head stainless steel captive screws threaded into stainless steel inserts in the housing casting. Continuous high temperature O-ring gasket for weather tight operation. Internal reflector is semi-specular anodized aluminum.

**Electrical:** H.I.D. Lampholder: Single ended porcelain G12 bi-pin with nickel plated contacts, rated 600V pulse rated 5KV. Ballasts: Magnetic HPF. Available in 120V or 277V - specify. Through Wiring: Maximum of four (4) No. 12 AWG conductors (plus ground) suitable for 90°C. Two 7/8" knockouts provided for 1/2" conduit.

**Finish:** Available in four standard BEGA colors: Black (BLK); White (WHT); Bronze (BRZ); Silver (SLV). To specify, add appropriate suffix to catalog number. Custom colors supplied on special order.

**UL** listed, suitable for wet locations and for installation within 3 feet of ground. Type non-IC. Protection class: IP65.

**Note:** Standard orientation of fixture is for downwards aiming of light only. For alternate orientations, consult factory.

Type:  
 BEGA Product:  
 Project:  
 Voltage:  
 Color:  
 Options:  
 Modified:



	Lamp	Lumen	A	B	C	CPC*
<b>3042 MH</b>	<b>ADA</b> 1 39W T6 G12 MH	3300	9 7/8	9 7/8	5 3/8	<b>524</b>

\*CPC: Optional Concrete Protection Cover



SECTION 27 51 23 - INTERCOMMUNICATION SYSTEM

PART 1 – GENERAL

1.01 SCOPE OF WORK

1. Supply and install a complete operational Intercommunication System consisting of public address and intercom integrated to the Centrex telephone system, time control system, and remote sound system.
2. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
3. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.
4. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
5. Requirements of the following Division 26 Sections apply to this Section:
  - a. General Provisions 260000
  - b. Basic Materials 260500
  - c. GPS Wireless Clock and Tone Generator System 275313
6. Existing PA system shall be relocated and remain operational during the project. Provide interconnection as required for new system and existing system to operate as one system.

1.02 SUMMARY

1. This Section includes programmable electronic communications network systems. It includes requirements for programmable electronic communications network system components including, but not limited to, the following:
  - a. Classroom/Administrative Telephones.
  - b. Ceiling Mounted Speaker Assemblies.
  - c. Digital LCD Readout units.
  - d. Digital Services Interface
  - e. Integrated Interactive Voice Response System
  - f. Controls, amplifiers, and terminal equipment.
  - g. Power supplies.
  - h. Battery Backup System
  - i. Wiring.
  - j. Wall mounted Paging Horns and Volume Attenuators.
  - k. AM/FM Roof Mounted Antenna.
  - l. AM/FM Tuner and cassette.
  - m. Integrated Telemedia Equipment
  - n. Assisted Listening System

2. Related Sections: The following Division 26 Section 260500 contains requirements that relate to this Section:
3. "Raceways," for raceways used for programmable electronic communications network systems cables.
4. "Electrical Boxes and Fittings," for boxes, cabinets and fittings used with communications systems.

#### 1.03 SYSTEM DESCRIPTION

1. General: Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating Integrated Programmable Electronic Communications Network. Telephone service with public utilities shall be arranged by the owner, in conjunction with the equipment supplier.

#### 1.04 SUBMITTALS

The information shall be provided for review in a phased submittal process. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase the project is beginning it will be returned, not reviewed. This is a phased project and the intercommunication system is required to be submitted to the Engineer in a manner that reflects the phasing of the project. The following shall be provided for each area under the present phase of construction for this project:

1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
  - a. Submit equipment prints, inter-panel and intra-panel, full electronic wiring diagrams and specification sheets for each item specified herein. Provide a tabulation of the specification clearly comparing the submitted item with the specified item, being able to refer to written expressed functions and capabilities. Specification Sheets shall be submitted on all items including cable types.
  - b. Shop drawings, detailing programmable electronic communications network system including, but not limited to, the following:
    - 1) Built-in station arrangement.
    - 2) Equipment cabinet arrangement.
  - c. Wiring diagrams, detailing wiring for power, signal, and control, differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminals to facilitate installation, operation and maintenance.
  - d. Submit wiring diagrams showing typical connections for equipment.
  - e. Provide a riser diagram for the system showing in technically accurate detail connections, interconnections, and provisions available and made for adaptability of specified future functions and including calculations, charts, and test data necessary to demonstrate that systems and system components deliver the specified signals, grades, and levels at required points and locations.
  - f. Submit a certificate of completion of installation and service training.



2. Conform to Shop Drawings, Product Data and Samples.
3. Submit Shop Drawings for the complete system.

1.05 QUALITY ASSURANCE

1. Items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing interconnections.
2. The contractor shall be an established communications and electronics contractor that has had and currently maintains a locally run and operated business for at least five years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer's warranty privileges.
3. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.
4. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
  - a. Article 250, Grounding.
  - b. Article 300, Part A. Wiring Method.
  - c. Article 310, Conductors for General Wiring.
  - d. Article 725, Remote Control, Signaling Circuits.
  - e. Article 800, Communication Systems.
5. EIA Compliance: Comply with the following Electronics Industries Association Standards:
  - a. Sound Systems, EIA-160.
  - b. Loudspeakers, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
  - c. Racks, Panels, and Associated Equipment, EIA-310-A.
  - d. Amplifiers for Sound Equipment, SE-101-A.
  - e. Speakers for Sound Equipment, SE-103.
6. UL Compliance: Comply with requirements of UL 50. The communication system supplied shall be listed by Underwriter's Laboratories under UL Standard 1459. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal.
7. Installation and start up of systems shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers and be prepared to offer a service contract for system maintenance on completion of the guarantee period and provide the names, locations, and size of ten (10) recent successful installations in the area.
8. The agency providing equipment shall be responsible for providing specified equipment and mentioned services for equipment as specified herein. The agency must be a local



authorized distributor of specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory- trained technicians for the specified equipment. The agency must have established business for and currently be providing services for the equipment to be provided for a minimum of twenty (20) years.

9. The contractor shall guarantee availability of local service by factory-trained personnel of specified equipment from an authorized distributor of all equipment specified under this section. On-the-premise maintenance shall be provided at no cost to the purchaser for a period of one (2) year from date of installation unless damage or failure is caused by misuse, abuse, neglect, or accident. Refer to phasing documents for warranty start and end duration.
10. The supplier shall visit the sites and familiarize himself with the existing conditions and field requirements prior to submitting a proposal.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

1. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

### PART 2 – PRODUCTS

#### 2.01 SYSTEM

1. The system shall consist of the central control unit, administrative control consoles, classroom and staff area DTMF phones, speakers and other necessary auxiliary devices to provide the operations specified herein.
2. The system as specified consists of a complete operational public address intercommunication system with DTMF phones in classroom and staff areas. The system shall be a redundant inter-communication system. Systems which use centralized head and equipment for both telephones will not be accepted.
3. The system specified is based on equipment manufactured by Telecor Inc. Systems manufactured by Rauland will be considered as long as they meet or exceed specifications.
  - a. The intent is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications.
  - b. The functions and features specified are vital to the operation of this facility, therefore, the acceptance of alternate manufacturers does not release contractor from strict compliance with the requirements of this specification.
  - c. The Contractor for this work shall be held to have read the Bidding Requirements, the General Requirements of Division 1, and Contract Proposal Forms; and in the execution of this work, he will be bound by the conditions and requirements therein. The equipment furnished under this specification shall be equal in performance and technology to that manufactured by Telecor Inc., Rauland-Borg.

- d. The contractor shall be responsible for providing a complete functional system including necessary components whether included in this specification or not.
- e. In preparing the bid, the bidder should consider the following:
  - 1) No claim will be made against the owner for any costs incurred by he bidder for any equipment demonstrations which the owner requests.
  - 2) The system proposed must have been installed in a customer's environment at least two years and be demonstrable. Experimental equipment will not be acceptable.
- f. Any prior approval of an alternate system does not automatically exempt the supplier from meeting the intent of these specifications. Failure to comply with the operational and functional intent of these specifications may result in the total removal of the alternate system at the expense of the contractor.
- g. Alternate equipment shall be considered if submitted to the specifying authority at least ten (5) days prior to bid date. Submission of an alternate shall contain engineering drawings of the system with specification sheets covering components of the system as well as items of paragraph 1.4 SUBMITTALS. The system and equipment drawing and specification sheet shall meet items of the specification.

## 2.02 SYSTEM REQUIREMENTS

- 1. General:
  - a. The system shall provide the state of the art in technology for outside and internal communications programming, secondary clock corrections and bell programming, voicemail, homework hotline, automated attendant, truancy notification, interactive voice response, data communication and media retrieval ability. The system shall be easy to learn and operate. Standard system programming shall be user friendly to allow the system administrator the ability to easily reprogram station features.
- 2. Provide complete and satisfactorily operating, integrated programmable electronic communications network as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturer's standard design and construction, in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- 3. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve. The integrated programmable electronic communications network system shall provide for direct connection to central office telephone lines (outside trunks). Initially the system shall be wired and equipped for (30) trunks.
- 4. The system shall offer routing of outside trunks for Attendant Answer incoming (AAI), Direct Inward Dialing (DID), Direct Inward Line Trunk (DIL), Private Direct Inward Line (PDIL), and Direct Inward System Access (DISA). It shall also provide all standard Telco signaling to interface with other special services such as Off Premise Extensions (OPX), WATS, CENTREX and TIE lines.

5. Incoming Caller ID (ICLID) shall be supported on inbound trunks.
6. The system shall provide direct interface to T-1 Service without the need for channel banks.
7. The system shall be ISDN ready, fully digital and shall provide ISDN to the desktop.
8. The system shall offer full flexibility of software restrictions to station lines for calling capability. Features shall be allowed or denied at two levels: 1) on a system basis; and 2) individually for each set and/or trunk.
9. The system shall allow system monitoring and administration from a terminal at a remote site.
10. The system shall be a global switching, dual-tone, electronic network consisting of multiple amplified intercom channels, (classroom) speakers, and/or telephones, digital readout for display of call origination, NMOS microprocessor and memory, solid state logic and sensing, and shall also provide two-wire balanced transmission with dial tone, ringing, and busy signal capabilities to stations.
11. The system shall lend itself to expansion by simple addition of modules.
12. The central switching system shall provide for automatic switching of the talk path to a telephone mode, during the course of a call, should the telephone associated with the speaker in use be lifted from its cradle.
13. The system shall be equipped with distinctive ringing which allows the party receiving a call to distinguish between an internal call and an outside call.
14. Two-way telephonic communication from any classroom phone to any office phone.
15. Two-way telephonic communication between any two phones in the system or any combination of phones in the system.
16. Two-way communication between any telephone and any room speaker.
17. Extension numbers shall be programmable and may be assigned any three or four digit number. Any extension may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.
18. Twenty (30) separate paging/class pass zones shall be provided; each location shall be programmed in software to belong to any combination of software zones. The system shall be connected to the public telephone trunk lines through FCC approved central office interface.
19. Public telephone calls shall be received by the system and routed to the designated attendant console and/or to the designated telephones.

20. Each telephone in the system shall be programmable for the following options:
  - a. Allow access to C.O. or external system trunks
  - b. Allow toll calls
  - c. Allow zone paging
  - d. Allow All-Page announcements
  - e. Allow executive override
  - f. Allow emergency paging.
  - g. Allow activation of Time Zone tones
  - h. Route all incoming calls to an optional speaker instead of ringing the phone
  - i. Allow direct access to media control lines
  - j. Set the priority level and target display of "normal" calls
  - k. Set the priority level and target display of "emergency" calls
  - l. Assignment of architectural number
  - m. Class of Service
  - n. Hunt pattern
  - o. Assignment of associated speaker to paging zone
  - p. Automatic Call-Back-Busy
  - q. Call forward-No Answer
  - r. Call forward-Busy
  - s. Call forward-Always
  - t. Unique Personal Identification Number code
21. The central communications system shall control public and inter-school telecommunications. The unit shall decode dial functions, using normal dial tone phones.
22. The attendant console and administrative phones shall be located in the office and where indicated on the plans, and these instruments shall be used for both public and inter-school communication.
23. Amplified two-way voice communication shall be available from any dial phone in the system, through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A warning tone shall sound and continue to sound at regular intervals when speaker monitoring is active.

### 2.03 SYSTEM OPERATION

1. The administrative communication system shall be the Telecor II System providing at least the following features and functions:
  - a. Direct dialing, two-way communications between locations equipped with Administrative Control Consoles and any location equipped with a speaker.
  - b. Automatic gain control on intercom speech to assure constant speech level.
  - c. Facilities for automatically sounding a warning tone over any loudspeaker selected for two-way communication to alert the classroom teacher to the call and to prevent unauthorized monitoring. The tone will sound whenever the classroom is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone from the administrative console if it is not desired.

- d. Facilities for the distribution of emergency announcements from the control console to locations equipped with control consoles or loudspeakers. Emergency announcements shall have the highest priority over any other system function.
- e. Facilities for the distribution of paging announcements from any administrative control console to speaker and console locations on all-call basis, or a pre-selected zone basis or multiple zone basis to any of the 8 paging zones. Speaker assignment to any of the 8 zones shall be user-programmable from the administrative control console.
- f. Capability of distributing audio program sources from the control console. Inputs shall be provided for low impedance microphones, tuner, tape player and auxiliary program distribution shall be accomplished on an ALL ROOMS basis or a SELECTED ROOMS basis as programmed from the console.
- g. Facilities for the control console to selectively monitor program sources being distributed to classrooms.
- h. Facilities for the automatic distribution of user programmable, class change time signals to areas activated by self-contained, 258-event programmable clock. Time signals shall be user programmable to any of the 8 available time zones. Time signal programming shall be accomplished from the control console. Four time schedules shall be provided.
- i. Capabilities for user programming of architectural room numbers from the control console.
- j. Digital readout of incoming calls by room number, priority and tone signal at control console.
- k. Facilities for up to 6 call-in priority levels. Each classroom shall be capable of being assigned to any one or more priority levels from the control console, allowing for emergency call-ins from classrooms.
- l. Facilities for reviewing incoming calls stored in memory, with sequential review of calls waiting.
- m. Facilities for displaying console clock in 24-hour or 12-hour format, selectable at the control console.
- n. Facilities for displaying incoming calls on a priority basis. Incoming calls will be sequentially displayed in order of priority. It shall be possible to review calls stored in memory in the order received.
- o. Facilities to place an incoming call on hold to carry out other console functions and recall them at a later time.
- p. Facility to clear calls registered in the system from the control console.
- q. Facilities to prevent monitoring of classrooms whose call switch is in the "privacy" position.
- r. Programmable functions shall be stored in a non-volatile memory and shall not be lost in event of a power failure.
- s. Capabilities of zoning incoming calls to annunciate at specific control consoles. Incoming calls from a designated group of classrooms shall annunciate at another console.
- t. Facilities to annunciate incoming calls at multiple consoles simultaneously. Calls may be answered from any annunciating console. Once answered, they shall be automatically canceled from other consoles.
- u. Facilities for manually distributing a tone signal to a select group of classrooms, and corridor speaker from a remote contact closure.

- v. Ability to interface to the school GPS wireless clock system, in order to utilize the clock system to transmit class change tones to select areas of the school. The duration of the tone, as well as frequency, burst length and output level shall be software programmable from the consoles. Systems employing external tone generators, not capable of being programmed from the console keypad shall not be acceptable.
- w. Provisions for the automatic distribution of Emergency Paging Announcements from a remote microphone. Keying the microphone shall automatically mute other audio programs in the system and transmit the microphone audio to All Rooms or specific speaker zones, as programmed into the system software.
- x. Facilities for activating and controlling remote devices from the console keypad. This shall provide controlling the operation of external bells, utilizing the internal time clock within the Telecor System.
- y. Capabilities of interfacing with a local Gym, Auditorium, Cafeteria, Media Conference and TV studio Sound Systems, providing automatic bridging of the local system, whenever it is accessed from the console. The system shall automatically track the local system, controlling the audio program as programmed from the control console.
- z. The system shall provide for the connection to the local building PABX or ELECTRONIC KEY telephone system. The Telecor System shall be capable of being accessed by the telephone system to allow access of external telephone lines.
- aa. Facilities for originating both "normal calls" and "emergency calls" from a single call switch. Emergency calls shall be initiated by merely depressing the call switch repetitively 3 times.
- bb. The system shall be equipped to accommodate a minimum of 600 classroom/staff areas. The system shall be capable of future expansion of up to 2000 classrooms and 32 control consoles.
- cc. The system shall include page overrides for local sound systems.

#### 2.04 DISTRIBUTION CHANNELS

- 1. The System shall provide true dual, simultaneous open voice speech paths MULTIPLE SPEECH or dual program distribution channels between MCC-4 Control Consoles and PROGRAM and Classroom loudspeakers. The following dual channel features shall be provided:
  - a. The speech paths shall be true dual, simultaneous open voice, unrestricted. Systems offering multi-speech paths which are restricted to a single speech path per group of room stations due to a hardware constraint will NOT BE ACCEPTED.
  - b. A minimum of 2 Audio Channels shall be provided for intercom communications and/or audio program distribution. The system shall be user programmable to allocate, upon demand, either of the two channels, to facilitate; 2 simultaneous intercom conversations; or 2 channels of program distribution; or 1 intercom channel and 1 channel for program distribution.
  - c. Any 2 MCC-4 Consoles shall be capable of independent, simultaneous communications with any two classrooms via the classroom loudspeaker and MCC-4 Consoles. There shall be no restrictions as to a single path per group of classrooms. Systems which limit the number of simultaneous conversations within a basic architectural group of room stations shall NOT BE ACCEPTABLE.

2.05 TELEPHONE CONVERSIONS

1. The System shall provide for full duplex, private telephone communications (classroom) between staff telephones, and/or MCC-4 Administrative Control Consoles. The following staff telephone and linkage features shall be provided:
  - a. Provide 4 simultaneous, full duplex private telephone links per group of 25 staff (classroom) telephones. The system shall be capable of modular expansion of 4 lines per 25 staff telephones. Systems which restrict linkage to less than 4 links per 25 phones shall be unacceptable.
  - b. The system shall be capable of being expanded to accommodate 600 staff telephones and provide 100 duplex private telephone links.
  - c. Staff telephone shall be carbon type with built-in networks. Systems using dynamic handsets shall not be acceptable.
  - d. Ability for any MCC-4 Administrative Console to transfer to interconnect any HS-4, Non-Dial, Staff (classroom) telephone to another HS-4 classroom telephone, providing for private full duplex telephonic classroom to classroom communications.
  - e. The system shall provide for direct dialing, private, 2-way, duplex, telephone communications from all locations equipped with a Telecor HS-5 telephone, to locations equipped with either an HS-4 or HS-5 telephone, and associated speaker or an MCC-4 Administrative Console. Any MCC-4 or HS-5 in the system shall be capable of direct dialing any other MCC-4, HS-5 or HS-4 in the system.
  - f. See attached cut sheets for more information.
  - g. Room stations (classrooms) equipped with staff phones as described above shall be capable of selectively calling MCC-4 Administrative consoles. Communications between staff phones and administrative consoles shall be full duplex.
  - h. Room stations (classrooms) equipped with HS-5 staff phones as described above shall be capable of:
    - a. Selectively calling classrooms and establishing open voice communications between the HS-5 and the classroom speaker.
    - b. Selectively initiating zone and All-Call paging announcements.
    - c. Selectively initiating calls to the KSU telephone system attendants console, and establish duplex telephone communications.

2.06 ADMINISTRATION CONTROL CONSOLE (Provide minimum of four)

1. The administrative control console shall be a TELECOR Model MCC-4, micro computer based, desk top console, occupying no more than 85 square inches of desk space. It shall be manufactured of high-impact, molded plastic with a moisture proof mylar face plate providing the following color coded function keys:
  - a. Room Select
  - b. Push-to-Talk
  - c. Hold
  - d. Page
  - e. Cancel
  - f. All Rooms
  - g. Selected Rooms
  - h. Microphone
  - i. Tuner

- j. Tape
  - k. Aux
  - l. Display Calls
  - m. Time Function
  - n. Program Function
2. The above keys shall be organized in a logical color-coded graphic format, permitting operators with little or no training to operate the basic Administrative functions.
  3. The console shall be equipped with a telephone handset with a retractable cord to allow private conversations. A built-in electret microphone and speaker shall provide for push-to-talk intercom conversations.
  4. Calls from classrooms shall be annunciated on and LED digital display by room number and priority level. Calls of a higher priority shall be displayed ahead of lower priority calls automatically. Incoming calls shall be held in memory and displayed in sequence. The 6 levels of incoming call priority shall be displayed by a unique display prefix and tone.
  5. Distribution of program sources (microphone, tuner, tape and aux) shall be accomplished from the console keypad, and distributed to classrooms on an All Call or Selected Room basis.
  6. The following user-programmable functions shall be programmed from the console keypad:
    - a. Architectural Room Numbers
    - b. Room Call-in Priority Levels
    - c. 12hr/24hr Clock
    - d. 256 Event, 8 Zone Program Clock
    - e. Speaker Paging Zone Assignment
    - f. Tone Characteristics
    - g. Console Zone Call-In
    - h. Tone Distribution From a Remote Location
    - i. Paging From a Remote Microphone
    - j. Secondary Time Clock Synchronization
    - k. Remote Circuit Activation
  7. Paging announcements shall be distributed from the control console on an Emergency All Call, All Call or Zone page basis to classroom speakers.
  8. Each of the control consoles may be programmed to receive and annunciate calls from specific pre-programmed zones of classrooms.
  9. Any control console shall have the ability to transfer, (swing) a specific zone of incoming calls or all calls from any console in the system, to any other console in the system. This shall be accomplished on a "handshake" arrangement by which 2 consoles must mutually agree to the transfer.

## 2.07 CENTRAL CONTROL UNIT

1. The Central Control Unit shall be a Telecor II, specifically designed for use with the MCC-4 control console. It shall be complete with circuitry for accomplishing functions for signaling



and communications for stations and 2 MCC-4 Control Consoles. The central control unit shall have provisions for expanding the system to 2000 stations, and 32 Consoles with the addition of plug-in modules, as required.

2. The Central Control Unit shall be complete with the circuitry to accomplish functions for full duplex private telephone communications for staff (classroom) telephones, and 12 telephone links. The system shall be capable of modular expansion of 4 links per 25 staff telephone to a maximum 600 telephones.
3. The Central Control Unit shall provide a 0 dBm signal for connections to an external amplifier for distribution of program audio, time signals and paging announcements.
4. The Central Control Unit shall enable the Telecor II system to provide the following features and functions:
  5. Instant direct dialing, two-way conversations between administrative consoles as well as to classroom speakers.
  6. Visual display of incoming calls in order of priority.
  7. Ability to review calls in the system.
  8. Retention of last room number dialed until another room number is dialed or previous call is cancelled.
  9. Single button response to call ins.
  10. Pre-announce tone alert to classroom of incoming calls.
  11. Instantaneous selection and distribution of program material on ALL-CALL or SELECTED ROOM basis, without the need for additional Room Selector Panels or Program Control Panels.
  12. Ability to program classroom priority at the Administrative control console.
  13. Ability to program and control a built-in master clock with 256 events, 8 time zones and 4 schedules.
  14. Choice of convenient handset or push-to-talk speaker/microphone communications.
  15. Ability to produce 8 different tone signals for classroom time changes or emergency signals.
  16. Ability to program tone characteristics (frequency, burst length, number of bursts and tone level) from the control console keypad, of all system tones.
  17. Ability to manually distribute tone signals on all-call basis from the keypad of the Administrative Control Console cabinet.

18. The unit shall contain required electronics on modular, plug-in type boards for ease of service and future expansion.

#### 2.08 MAIN EQUIPMENT CABINETS

1. The cabinets shall be a metal upright type with louvers and locking solid rear door. The unit shall contain 61" of mounting space for accommodating all equipment specified. The cabinets shall have internal mounting rails and AC power strips to accommodate equipment to be housed within racks. A front locking plexiglass door shall also be provided.
2. Provide multi-service custom control panel identified as "CP on plans. The control panel to contain, PA speaker, speaker perforation, intercom phone, light switches, thermostat and carbon dioxide sensor. The flush mounted locking enclosure shall be manufactured by Cowell Manufacturing Company. Refer to Control Panel detail for specific requirements. The thermostat and carbon dioxide sensor shall be furnished, wired and installed on the face of the control panel by the Division 15 Contractor. Coordinate with Division 15 Contractor for appropriate thermostat and carbon dioxide sensor space and mounting requirements.

#### 2.09 AM/FM TUNER /CD PLAYER

1. The AM/FM Cassette Player shall be a Telecor Model TC-1PD or approved equal. The unit shall be equipped with an LED tuning display, front panel indicators, internal clock, base, treble, and volume controls. The AM section shall be tunable over a range of 525 to 1620 kHz. The FM section shall be tunable over a range of 88 to 108 MHz.
2. The cassette player shall be capable of playing standard audio cassettes at a speed of 1-7/8 ips. The controls shall include play, stop, fast forward and reverse. It shall have a frequency response of 50 Hz – 15 kHz.
3. Provide a CD player capable of playing all standard compact disks. The CD player shall be rack mountable.

#### 2.10 POWER AMPLIFIERS

1. Power amplifiers shall be Telecor Model 125, employing silicon transistors. The amplifiers shall be capable of producing an audio output of 125 watts RMS at less than 1% distortion and shall have a peak of over 125 watts. They shall be designed to operate on a line voltage of 115 AC. Two amplifiers shall be provided, one for each channel.

#### 2.11 DIRECT DIGITAL INTERCONNECTS

1. Provide a minimum of four direct digital connections between public address system and Centrex system.
2. Centrex phones shall have the ability for paging individual areas, zone paging and emergency all call paging.

2.12 CLASSROOM SPEAKERS/CORRIDOR SPEAKERS

1. Provide 8" loudspeaker and transformer with 12" white enamel baffle, tile bridge support and back box for all corridor, office areas and classroom areas and as shown on drawings.
2. Provide 15 watt re-entrant loudspeakers with vari/tap transformers which are vandalproof to be used for gym areas.
3. Speakers in shall be home run back to main public address system via a dedicated, twisted, shielded cable per room.
4. Provide weatherproof, vandalproof speakers for exterior locations.

2.13 MEDIA CENTER AND MEDIA CENTER CLASSROOM

1. Provide one 150 watt wall mount amplifier with 2 modular microphone inputs and 2 auxiliary modular inputs. System shall be integrated to main public address system and shall be overridden during all call paging.
2. Provide 4 Soundsphere 2212-1 speakers with accessory mounting hardware. Speakers shall provide 200watts RMS power. Speakers shall be mounted adjacent to acoustical ceiling (to be coordinated with electrical engineer) and suspended from a metal cable.
3. Provide 2 hand held microphones with 25 feet of cable and XLR connectors.
4. Provide minimum of two flush mount wall, mount microphone jacks.
5. Provide 2 Telex wireless microphones, one hand held and one lavalier type to include receiver, amplifier modules and connect to cub sound system equipment in student commons area.
6. Provide eight 15 watt re-entrant paging speakers and connect to main public address system. These speakers shall be used for individual room communication and paging.
7. Systems shall have UPS-battery backup for full load and 20 minutes.

2.14 TV STUDIO SOUND SYSTEM

1. Provide one 150 watt wall mount amplifier with 2 modular microphone inputs and 2 auxiliary modular inputs. System shall be integrated to main public address system and shall be overridden during all call page.
2. Provide 12 Soundsphere 2212-1 speakers with accessory mounting hardware. Speakers shall provide 200 watts RMS power. Speakers shall be mounted recessed in the ceiling and connected to the cafeteria sound systems amplifier. Each speaker shall be wired back individually and have the ability to use each speaker individually, in combinations or all simultaneously.

3. Provide 2 hand held microphones with 50 feet of cable and XLR connectors.
4. Provide minimum of two flush mount wall, mount microphone jacks.
5. Provide 2 Telex wireless microphones, one hand held and one lavalier type to include receiver, amplifier modules and connect to sub sound system equipment in student commons area.
6. Provide four 15 watt re-entrant paging speakers and connect to main public address system. These speakers shall be used for individual room communication and paging.
7. Systems shall have UPS-battery backup for full load and 20 minutes.

#### 2.15 CAFETERIA SOUND SYSTEM

1. Provide one 150 watt wall mount amplifier with 2 modular microphone inputs and 2 auxiliary modular inputs. System shall be integrated to main public address system and shall be overridden during all call page.
2. Provide 12 Soundsphere 2212-1 speakers with accessory mounting hardware. Speakers shall provide 200 watts RMS power. Speakers shall be mounted recessed in the ceiling and connected to the cafeteria sound systems amplifier. Each speaker shall be wired back individually and have the ability to use each speaker individually, in combinations or all simultaneously.
3. Provide 2 hand held microphones with 50 feet of cable and XLR connectors.
4. Provide minimum of two flush mount wall, mount microphone jacks.
5. Provide 2 Telex wireless microphones, one hand held and one lavalier type to include receiver, amplifier modules and connect to sub sound system equipment in student commons area.
6. Provide four 15 watt re-entrant paging speakers and connect to main public address system. These speakers shall be used for individual room communication and paging.
7. Systems shall have UPS-battery backup for full load and 20 minutes.

#### 2.16 GYM AND AUDITORIUM SOUND SYSTEM

1. These systems are existing and shall remain.

#### 2.17 ASSISTED LISTENING SYSTEM

1. This section of the specification includes the furnishing, installation, connection and testing of the assisted listening sound equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to microphone, amplifiers speakers and wiring as shown on the drawings and specified herein.

2. System components shall be provided as follows and manufactured by Telex Communications, Inc.
3. Cafeteria, Media Center, TV studio, Media Center Classroom and Gym shall incorporate the following:
  - a. Provide (4) base station transmitters #ATT-2N. The base station transmitter shall have inputs for the following audio sources: direct microphone (local) and amplifier (public address system).
  - b. Provide (4) belt pack transmitter #TW6AA for portable use with 30 hour NICAD battery.
  - c. Provide (8) single channel receivers #AAR-ION with (2) AAA batteries per receiver.
  - d. Provide charging stations as required for receivers.
4. Auditorium shall incorporate the following:
  - a. Provide (6) base station transmitters #ATT-2N. The base station transmitter shall have inputs for the following audio sources: direct microphone (local) and amplifier (public address system).
  - b. Provide (6) belt pack transmitter #TW 6AA for portable use with 30 hour NICAD battery.
  - c. Provide (18) single channel receivers #AAR-ION with (2) AAA batteries per receiver.
  - d. Provide charging stations as required for receivers.
5. Classroom locations (as noted on documents) shall incorporate the following:
  - a. Provide (2) base station transmitters #ATT-2N. The base station transmitter shall have inputs for the following audio sources: direct microphone (local) and amplifier (public address system).
  - b. Provide (2) belt pack transmitter #TW 6AA for portable use with 30 hour NICAD battery.
  - c. Provide (18) single channel receivers #AAR-ION with (2) AAA batteries per receiver.
  - d. Provide charging stations as required for receivers.

#### 2.18 CLASSROOM HEARING AMPLIFIED SYSTEM

1. This section of the specification includes the furnishing, installation, connection and testing of the hearing amplified sound equipment required to form a complete, operative, coordinated system for each and every classroom and theory room. It shall include, but not be limited to microphone, amplifiers speakers and wiring as specified herein.
2. System components shall be provided as follows and manufactured by Phonic Ear.
3. The Phonic Ear Sound Field System:
  - a. Provide thirty (30) base station receivers part #PE 210R, transformers part #ATO577, antennas part #AT0566, auxiliary cord part #AT0653-30.
  - b. Provide thirty (30) transmitters part #PE 300T, fifteen (15) 2-unit chargers part #AT 534, thirty (30) nicad rechargeable batteries part #AT 0665, thirty (30) transmitter belts part #AT 712, fifteen (15) lavalier cords part #AT0512 and

- fifteen (15) wire clips part #AT0489 thirty (30) behind the neck microphone with mute switch Part #AT 655m, thirty (30) auxiliary input cords part #AT 532.
- c. Provide ceiling speakers in locations as noted on the documents. The ceiling speaker shall be manufactured by Phonic Ear. The part number is #AT0664. The speaker shall be wired to a stereo wall jack suitable and compatible with the Phonic Ear Sound Field System. A ten (10) foot patch cord suitable and compatible with the system shall be provided for interconnection between speaker wall jack and the base station receivers.
  - d. A 120 volt receptacle shall be provided within one (1) foot of the speaker jack.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

1. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the programmable electronic communications network system work.
2. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

1. General:
  - a. Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.
2. Wiring Methods:
  - a. Install wiring in raceway except within consoles, desks, and counters, and except in accessible ceiling spaces, and in gypsum board partitions, where cable wiring method may be used. Use UL listed plenum cable throughout. Conceal wiring except in unfinished spaces. Refer to Section 260500.
3. Impedance and Level Matching:
  - a. Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
4. Control Circuit Wiring:
  - a. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
  - b. The contractor shall mount a main distribution frame behind the programmable electronic communications network console. Wires shall be laid down on terminal punch blocks and identified by the actual room location it serves. Communications points shall be wired into this main distribution frame, laid down in sequence, and identified by which line it is on and the point position it serves.
  - c. Housings are to be located as specified and shown on drawings.
  - d. Make installation in strict accordance with approved manufacturer's drawings and instructions.

- e. The contractor shall provide necessary transient protection on the AC power feed, station lines leaving or entering the building, and central office trunks. Protection shall be as recommended by the equipment supplier and referenced to earth ground.
- 5. Wiring Within Enclosures:
  - a. Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
  - b. Provide physical isolation from each other for speaker- microphone, line-level, speaker-level, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones and adjacent parallel power and telephone wiring. Provide physical separation as recommended by equipment manufacturer for other programmable electronic communications network system conductors.
- 6. Splices, Taps, and Terminations:
  - a. Make splices, taps and terminations on numbered terminal punch blocks in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.
- 7. Identification of Conductors and Cables:
  - a. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- 8. Weatherproofing:
  - a. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.
- 9. Refer to specification section 26000 3.8 for maintenance requirements.
- 10. Repairs:
  - a. Wherever existing walls, ceilings, floors, or other existing building finishes are cut for installation, repair and rough patch.

### 3.03 GROUNDING

- 1. Provide equipment grounding connections for programmable electronic communications network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- 2. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
- 3. The contractor shall provide transient protection on the AC power feed and on station lines leaving or entering the building.

4. The contractor shall note in his system drawings, the type and location of these protection devices as well as wiring information.
5. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground bus bar. Refer to Section 260500.

#### 3.04 FIELD QUALITY CONTROL

1. Manufacturer's Field Services:
  - a. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
2. Inspection:
  - a. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
3. Testing:
  - a. Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

#### 3.05 COMMISSIONING

1. Refer to specification section 260000, paragraph 2.1 for Video recording requirements.
2. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of 64 hours training. The contractor shall also provide a minimum of 64 hours of in-service training with this system for end users. These sessions shall be broken into (4) 2-day segments, which will facilitate the training of individuals in the operation of this system. This does not include travel time. Operators Manuals and Users Guides shall be provided at the time of this training.
3. Schedule training with Owner through the Architect, with at least seven days advance notice.
4. Occupancy Adjustments:
  - a. When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.



3.06 CLEANING AND PROTECTION

1. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION

SECTION 27 53 13 - GPS WIRELESS CLOCK AND TONE GENERATOR SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

1. Section Includes: Division 1 applies to this section. Provide GPS wireless clock system and synchronized wireless tone generator system, complete, including generator, transmitter, receiver, software, and related accessories.
2. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
3. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.
4. Related Work Specified Elsewhere:
  - a. 120 volt grounded electrical outlet within 6 feet of transmitter location.
  - b. 120 volt grounded electrical outlet within 6 feet of wireless tone generator, and computer time sync.
  - c. Public address systems, physical bells, and other accessories actuated by the wireless tone generator.
  - d. Installation of operating software shall be on a computer designated by the owner.

1.02 DEFINITIONS

1. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.
2. GPS/Transmitter Cable: A specially designed low resistance data cable can be used to extend the distance between the transmitter and the GPS Unit.
3. CD-ROM: Compact disk, read-only memory.
4. PC: Personal computer (Owner-furnished)
5. WT: Wireless Tone.
6. WT Generator: Wireless Tone Generator.

1.03 SYSTEM DESCRIPTION

1. The system shall provide GPS wireless synchronized precision clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired. The WT Generator and every other component in the system shall use both precise time and synchronized time.

2. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
3. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
4. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
5. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
6. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.
7. The WT generator system shall provide a tone at pre-defined times to an Owner-furnished public address system, or to Owner furnished bell system. The tone shall actuate all devices programmed to operate on receipt of the tone.
8. Timing and operation of the WT generator system shall be controlled by software provided by system manufacturer, housed in the transmitter and programmed by an Owner-furnished PC.
9. The system shall not require wiring from the transmitter to WT generator.
10. WT Generator: Initially and at scheduled intervals, the WT Generator receives the time data and command packet from the transmitter. Using that information, the WT Generator can send an audio tone to and an existing PA-type announcement system and/or an existing bell system.
11. The transmitter shall continuously broadcast (transmit) a time data packet and command packets to the WT generator. The transmitter shall operate on FCC licensed frequencies that have good building penetration and that are regulated by the FCC to minimize interference on the selected channel.
12. The GPS unit shall receive the precise time via satellite from its vantage point with a 'view of the sky' and continuously provide this precise time to the transmitter.
13. The system shall incorporate fail-safe design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.

#### 1.04 REGULATORY REQUIREMENTS

1. Equipment and components furnished shall be of manufacturer’s latest model.

2. Transmitter and receiver shall comply with Part 15 and Part 90 of FCC rules, as follows:
  - a. This device may not cause harmful interference, and
  - b. This device must accept any interference received, including interference that may cause undesired operation.
  - c. Transmitter frequency shall be governed by FCC Part 90.35.
  - d. Transmitter output power shall be governed by FCC Part 90.257 (b).
3. System shall be installed in compliance with local and state authorities having jurisdiction.
4. Unauthorized changes or modifications to the equipment will void the Owner's authority to operate the equipment.

#### 1.05 SUBMITTALS

1. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
  - a. In accordance with FCC regulations, an application for license must be filed prior to use of the equipment. The Contractor shall complete the filing and obtaining the license.
2. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.
3. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
4. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions. Submit software programming instructions, coordinated with the Owner's requirements for timing and sequencing of the equipment.
5. Manufacturer's and Installer's Qualifications: Submit evidence of qualifications of manufacturer and installer, as specified in section 1.7.

#### 1.06 SUBSTITUTIONS:

1. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
2. Proposed substitutions shall be acceptable as indicated in the bid documents.
3. Systems requiring wiring and/or conduit between master and clocks, or which require connection of clocks to external electrical power supply, will not be acceptable.

#### 1.07 QUALITY ASSURANCE

1. Permits: Obtain operating license for the transmitter from the FCC.

2. Qualifications:
  - a. Manufacturer: Company specializing in manufacturing time systems with a minimum of 10 continuous years of documented experience.
  - b. Installer: Company with documented experience in the installation of computer controlled, time-actuated control systems. Company shall have a valid license to perform electrical work in the jurisdiction in which the project is located.

#### 1.08 DELIVERY, STORAGE AND HANDLING

1. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
2. Store equipment in finished air conditioned portion of the building, unopened containers until ready for installation.

#### 1.09 PROJECT SITE CONDITIONS

1. Clocks shall not be installed until painting and other finish work in each room is complete.
2. Coordinate installation of GPS receiver with work on the roof so that the bracket and related fasteners are watertight.
3. Verify that a PC having the specified minimum system requirements will be available for use in programming the WT generator.

#### 1.10 SYSTEM STARTUP

1. At completion of installation and prior to final acceptance, start up the equipment; assure that all equipment is operating properly, all clocks are functioning, all units connected to the system are receiving tones as programmed.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURER

1. GPS wireless clock and tone generator system shall be manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva WI 53147 (800) 537-0464 FAX (262) 248-0061 [www.primexwireless.com](http://www.primexwireless.com) or approved equal by brgprecision or Symmetricom.

#### 2.02 SEQUENCE OF OPERATION

1. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

2. Analog Clock Operation:
  - a. When the batteries are inserted into the clock: A) Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand. B) After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand.
  - b. After the red button has been pressed twice, the micro processor will start searching the channels. It will start at channel No. 1 and proceed one by one until it either decodes a valid signal or reaches channel No. 16. If no signal is detected the receiver will be shut off and will try again later. If a signal is received, the micro processor will store the channel number, set the clock to the receiver time. For the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area. Analog clocks can operate in marginal signal areas, but battery life will be about 25 percent shorter.
  - c. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.
  - d. If the clock has not decoded a valid time signal for seven days, then it will go back to a double-step mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.
3. Transmitter Programming: After the transmitter has been set up and is operating correctly, it is programmed to transmit a signal to the WT generator at predetermined intervals. This programming shall be done as part of the contract, in coordination with the Owner. A personal computer, having the minimum requirements specified below in Section 2.4, is required for programming.
4. WT Operation: When the WT generator receives a signal from the transmitter it shall generate a tone to actuate the devices that have been predetermined to operate upon receipt of that tone.
5. The WT generator system shall include a WT generator, programming software, and all accessories for complete operation. The unit shall obtain current atomic time from satellite; the system shall transmit time and control packets continuously to one or more WT generators in the system.

## 2.03 EQUIPMENT

1. General: The clock system shall include a transmitter, a roof mounted GPS receiver, indicating clocks, and all accessories for complete operation.
2. Transmitter: Primex Wireless Model FM-72, consisting of wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.
  - a. Transmission:
    - 1) Frequency Range: 72.100 to 72.400 MHz.

- 2) Transmission Range: one mile, open field.
    - 3) Radio technology: narrowband FM
    - 4) Number of channels: 16
    - 5) Channel bandwidth: 20 kHz maximum
    - 6) Transition mode: one-way communication
    - 7) Data rate: 2 KBps
    - 8) Operating range: 0 degrees C. to 70 degrees C.
  - b. Transmitter:
    - 1) Transmitter output power: +26 to +30 dBm
    - 2) Frequency deviation: +/- 4 kHz
    - 3) Transmitter power requirements: 120 VAC 60 Hz
    - 4) Internal power requirements: 5 VDC
    - 5) Carrier frequency stability: +/- 20 ppm
  - c. Transmitter shall have 16 selectable channels to assure interference-free reception.
  - d. Transmitter shall have the following switches:
    - 1) Time zone adjustment switches for all time zones in the world. Includes all US time zones: Eastern, Central, Mountain, Pacific, Alaska and Hawaii.
    - 2) Daylight Saving Time bypass switch.
    - 3) 12-hour or 24-hour display.
  - e. Transmitter housing shall be black metal case, 16-3/4 inches by 12 inches by 1-7/8 inches in size.
  - f. Antenna shall be 46 inches high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.
  - g. Transmitter housing shall incorporate a display which shall include the following:
    - 1) Time readout
    - 2) AM and PM indicator if 12-hour time display is set
    - 3) Day and date readout
    - 4) Indicator for daylight savings or standard time
    - 5) LED which shall flash red in event of reception problem
    - 6) GPS reception indicator
  - h. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks or the WT generator.
3. Power supply:  
Model Number: 140003  
Input: 120 volt AC 50/60 Hz, 0.4 amp.  
Output: 9 volt DC, 1.5 amp.
4. GPS Receiver: Model Number Q11695, GPS roof mounted, with 15 foot cable attached and an additional 100 feet of Primex Wireless extension cable.
- a. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, 3-7/8 inches by 4-3/16 inches by 2 inches, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
5. Traditional analog clocks: Primex Wireless analog clocks, 12-1/2 inch diameter or 16 inch diameter as selected, color and finish as selected from manufacturer's standard colors and finishes. Analog clocks shall be wall mounted, and 12-1/2 inch diameter clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Analog clocks shall be provided with red sweep second hand.

- a. Each analog clock shall be battery-operated, and shall have 5-year battery life.
  - b. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
  - c. Time shall be automatically updated from the transmitter 6 times per day.
  - d. Analog clocks shall remember the time during changing of batteries.
  - e. Tamper-proof/theft resistant hangers and slots in the backs of the analog clocks shall be provided.
  - f. Provide 2 alkaline D-cell rechargeable batteries and 120 volt power supply with each 12-1/2 or 16-inch analog clock.
  - g. Analog clock receivers shall be as follows:
    - 1) Receiver sensitivity: >-110 dBm
    - 2) Receiver power: two alkaline D-cells
    - 3) Antenna type: internal
    - 4) Antenna gain: -7 dBd
  - h. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
  - i. Provide the following traditional series clocks with black housing:
    - 1) 12-1/2 inch clock shall be Model #14155
    - 2) 16 inch clock shall be Model #14163
6. Wire guards: Provide one for each analog clock as follows:
- a. Model No. 14131, 14 by 14 inch size, for nominal 12-1/2 inch diameter analog clocks.
  - b. Model No. 14123, 18 by 18 inch size, for 16 inch diameter analog clocks.
7. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.
8. Wireless Tone Generator shall be Model Number 14002, WT generator, complete with cables and antenna required for complete installation. Locate where indicated on plans.
- a. Size: Approximately 7-1/4 inches wide by 5 inches long by 1-1/2 inches high, not including antenna.
  - b. Generator shall be housed in a black plastic case.
  - c. 9 volt switching power supply (fed from 120 volt line)
  - d. Switching contacts "Form D", two sets: one normally open, one normally closed.
  - e. Switch ratings:
    - 1) Contact ratings:  
5 amp, 1/6 hp, 125v, 250v, AC  
5 amp, 20 volts DC
    - 2) DC Break ratings:  
30 watt maximum  
One amp, 30 volts, DC; 24 amp, 125 volts DC
  - f. Audio Output:
    - 1) Isolation transformer with center tap, 600/150 ohms output impedance
    - 2) Variable output and line level
  - g. Relay output
  - h. Test and reset buttons
  - i. Signal indicator



- j. One hundred switch identification codes. Any number of switches for each identification code.
  - k. Selectable channels: 16
  - l. 24 programmable events with 7 day selectable operations.
  - m. Selectable options for each event, as follows:
    - 1) None
    - 2) Turn on 5 seconds
    - 3) Turn on and stay on
    - 4) Turn off and stay off
    - 5) Turn on 2 seconds, off 1 second, on 2 seconds
    - 6) Turn on 3 seconds
    - 7) Turn on 1 second then off 1 second (repeat 5 times)
    - 8) Turn on 3 seconds, off 3 minutes, on 3 seconds, off 2 minutes, on 3 seconds
    - 9) Turn on 3 seconds, off 4 minutes, on 3 seconds, off 1 minute, on 3 seconds
    - 10) Turn on 3 seconds, off 5 minutes, on 3 seconds, off 1 minute, on 3 seconds
    - 11) Turn on 1 second
  - n. Selectable daylight saving time bypass.
  - o. Selectable automatic channel scanning.
  - p. Computer programmable through transmitter, with automatic backup, and schedule changes that are easy to make.
  - q. Switching information stored in non-volatile memory in the transmitter and broadcast at regular intervals. Each switch retains its instructions in non-volatile memory.
  - r. WT generator shall be factory preset as follows:
    - 1) Channel I.D. No.: 1
    - 2) Switch: 00
    - 3) Volume: 25 percent
9. Provide wall-mounted steel transmitter rack for each transmitter.
- a. Model No. 14005
10. Provide surge protection and battery back-up system for each transmitter, tone generator and computer time sync.
- a. Model No. 14196
11. Provide computer time sync to connection to the computer data system. Locate where indicated on plans.
- a. Model No. 14012
12. Provide (12) spare clocks to the owner.

#### 2.04 SOFTWARE

- 1. Provide Primex Wireless Scheduler Model 14003 software for installation and programming by Owner, compatible with the following PC operating systems:
  - a. Windows 95 with Internet Explorer 5.01 Service Pack 2.
  - b. Windows 98

- c. Windows ME
  - d. Windows NT with Service Pack 6a, Internet Explorer 5.01 Service Pack 2, and valid administrator rights.
  - e. Windows 2000 with valid administrator rights.
  - f. Windows XP with valid administrator rights.
2. Software shall be in form of a CD, suitable for operation in standard CD-ROM drives.
  3. Provide one cable, RS232 (9 wires straight through DB9-F/DB9-M) with USB-to-serial adapter if required for use in downloading programmed software to the WT generator.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

1. Verify that construction is complete in spaces to receive equipment and that rooms are clean, dry, and permanent air conditioning systems are operating.
2. Verify that 120 volt electrical outlet is located within 6 feet of location of transmitter, and that outlet is operational and properly grounded.
3. Verify that a compatible PC, meeting requirements specified above, is available for dedicated use during software installation and system testing.

#### 3.02 INSTALLATION

1. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
2. Transmitter:
  - a. Locate transmitter where indicated on the drawings, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. Install transmitter, 2 to 3 feet above the floor on transmitter rack. The transmitter is designed for interior use only. It is not weatherproof.
  - b. Attach receiver to transmitter using cable.
  - c. Connect antenna to transmitter, using care not to strip threads.
  - d. Connect power supply to the transmitter.
  - e. Set the channel number on the display to correspond to the FCC license.
  - f. Plug power supply into electrical outlet.
3. Analog clocks: Perform the following operations with each clock:
  - a. Install D-cell batteries.
  - b. Set clock to correct time in accordance with manufacturer's instructions.
  - c. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.

- d. Install the analog clock on the wall in the indicated location, plumb, level and tight against wall. If using 12-1/5 inch clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
4. Wire guards: Secure to wall, using approved theft-resistant fasteners.
5. WT Generator:
  - a. Install the WT generator in location indicated on the drawings, and secure to base using fasteners of type recommended by WT generator manufacturer, and suitable for the surface to which it is attached.
  - b. Align the antenna vertically.
  - c. Verify that the factory switch settings as specified above are correct. If changes are required due to field conditions, perform the following operations:
    - 1) Verify that the channel selector on the outside of the WT generator matches the selected channel on the transmitter.
    - 2) Verify the switch ID selector on the outside of the WT generator matches the selected switch ID number on the scheduling software.
    - 3) Remove the smaller cover, then the larger cover from the unit for access to the selector switches. Set the dip switches as required for daylight savings time adjustment.
    - 4) Adjust WT generator volume as required.
  - d. Confirm proper installation of the WT generator and check volume by holding down the test function button.
  - e. Press the "reset" button to effect any changes in settings.
  - f. Relay output: If required, connect the relay output to the devices to be controlled. Confirm compatibility between relay output and devices.
  - g. Connect the WT generator to a standard 120 volt outlet.
  - h. Confirm that the green LED is flashing, to indicate that the WT generator is receiving a signal from the transmitter.

### 3.03 ADJUSTING

1. Prior to final acceptance, inspect each item, adjust as required, modify the software as directed, and replace parts which are found defective.

### 3.04 CLEANING

1. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

### 3.05 DEMONSTRATION AND TRAINING

1. Provide (2) days of training to Owner's representative on setting and adjusting clocks, replacing batteries, installing the software, adjusting and programming the transmitter, setting and adjusting WT generators and routine maintenance.

3.06 WARRANTY

1. The contractor and manufacturer shall provide a comprehensive (5) year warranty including all parts and labor on equipment.

3.07 PROTECTION

1. Protect finished installation until final acceptance of the project. Refer to phasing documents for additional information.

END OF SECTION

SECTION 28 31 00 - ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 SCOPE & RELATED DOCUMENTS

1. The work covered by this section of the specifications includes the furnishing of labor, equipment, materials, and performance of each operation in connection with the installation of the Fire Alarm System as shown on the drawings and as herein specified.
2. The requirements of the conditions of the Contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
3. See other Division 26 sections for requirements of specific electrical equipment and systems not included herein.
4. Refer to specification section 260000, paragraph 2.1 for Video recording of material, equipment, operation and training.
5. The complete installation is to conform to the applicable sections of NFPA-72, Local Code Requirements and National Electrical Code with particular attention to Article 760.
6. The work covered by this section of the specifications is to be coordinated with the related work as specified elsewhere under the project specifications.
7. The existing building will be in operation throughout construction. The existing fire alarm system shall remain in operation until the new system has been installed and tested. The existing fire alarm system shall be removed completely following acceptance of new system.
  - a. Refer to Section 260050 and coordinate with Architect and Owner.

1.02 QUALITY ASSURANCE

1. Each item of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. Equipment provided shall be listed under UL 864 9th Edition to insure the latest revision of control equipment. Equipment that does not have UL 864 9th Edition or that has 9th Edition pending will not be approved. Manufacturer shall provide copy of UL 9th Authorization letter if requested. Control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing shall not be acceptable.
2. The equipment and installation supervision furnished under this specification is to be provided by a manufacturer who has been engaged in production and/or installation of this type (software driven) of equipment for at least ten (10) years, and has a fully-equipped service organization within fifty (50) miles of the installation.

3. Before commencing work, submit data showing that the contractor has successfully installed fire alarm system of the same type and design as specified or that they have a firm contractual agreement with a subcontractor having the required manufacture's training and experience. The contractor will include the names and location of at least two installations of similar size and complexity where the contractor, or his subcontractor have installed such systems.
4. Control equipment must have transient protection devices to comply with UL864 requirements. Provide an isolated loop protector device on any circuit including power, telephone, signal, initiating device, or notification appliance device circuit that extends beyond the main building by either aerial, underground, or other method.

### 1.03 SHOP DRAWINGS

The information shall be provided for review in a phased submittal process. The information provided in the phased project submittal shall be for that phase for which the project is presently beginning. If the information in the submittal is more than the scope of the phase the project is beginning it will be returned, not reviewed. This is a phased project and the Fire Alarm System controls are required to be submitted to the Engineer in a manner that reflects the phasing of the project. The following shall be provided for each area under the present phase of construction for this project:

1. Prior to submittal of drawings:
  - a. First: Obtain Architect's approval for revisions to layouts shown on Contract Documents.
  - b. Second: Submit shop drawings to the local Fire Marshal or other Authority Having Jurisdiction for review and approval prior to commencing construction.
2. Shop Drawings: Provide detailed equipment assemblies, method of field assembly, and components.
  - a. Intelligent addressable fire alarm control panel, manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, supervised control modules and accessories.
  - b. Conventional non-addressable devices as required for performance to this specification.
  - c. Audible and visual evacuation signals and devices.
  - d. Wiring and conduit to include circuit load and spare capacity.
  - e. Detailed sequence of operation.
3. Data describing more than one type of item shall be clearly marked to indicate the type the contractor intends to provide for a given application. The reviewing authority will assume that options not crossed out in submittal material will be furnished for the project. Submittal material shall be complete. Partial submittals will not be accepted. Submit copies of UL listing or FM approval data showing compatibility of the proposed device or appliance and the panel being provided.

4. Complete drawings covering the following shall be submitted for the proposed system:
  - a. Floor plans showing initiating, end of line, supervisory, notification appliances, and output control devices.
  - b. Wiring diagrams showing points of connection and terminals used for electrical connections to the existing system devices and panels.
  - c. Submit project-specific, complete riser diagram showing interconnections of panels, modules, and point-to-point wiring between devices including wire types and major junction boxes required for the project.
  - d. A complete proposed system database including a description of logic strings, control by event programming and point identification labels on a compact disk (CD) and in a formatted printed form, required for off site editing, uploading and downloading shall be submitted for evaluation by the Owner. A programming manual shall accompany the submitted program and shall be adequate to allow understanding, operation and editing by the system owner.
5. Submit a schedule of initiating devices, listing device type, location, zone (if applicable), and software address.
6. Submit a matrix or table listing each output control function (e.g. fan shutdown, elevator recall, door release) and its corresponding initiating addresses.
7. Submit calculations for the sizing of power supplies, batteries, and audio amplifiers.
8. Submit a copy of the field installer's NICET Level 3 certificate in Fire Protection Engineering Technology, Fire Alarm Systems.
9. For use in system test, a complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.
  - a. The following information shall be inscribed on the cover:
    - 1) "OPERATION AND MAINTENANCE MANUAL"
    - 2) Building location.
    - 3) The name of the contractor, system manufacturer and system subcontractor.
    - 4) The name and phone number of the fire department required to respond to alarms at the project location.
  - b. The manual shall be legible and easily read with large drawings folded and contained in pockets. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item of equipment and a control sequence describing start up instructions. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.

10. Upon completion of the installation, "as-built" record drawings shall be submitted on each system before final acceptance of the work. Furnish to the Engineer a set of "as-built" record drawings including updated system riser diagrams for each system. The record drawings masters shall be on reproducible vellum uniformly sized as required for legibility and reproduction and on a compact disk (CD) in a DXF format suitable for use in a CAD drafting program.

#### 1.04 SUBMITTALS

1. Submit manufacturers' technical product data for fire alarm system equipment and devices, and including description of operation, specifications, dimensions and finishes. Clearly mark options and features furnished, and strike out items, options, and features not being furnished.
2. Submit a minimum of (2) additional Factory Authorized Independent Distributors within 50 miles of the project that can maintain, service, and add to the proposed system.

#### 1.05 GENERAL

1. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. The system shall be microprocessor-controlled, intelligent reporting, electrically supervised, low-voltage, power-limited, non-coded utilizing one-way voice communication with individually addressable manual and automatic initiating devices and circuits, and individually addressable output control functions. The system shall use closed loop initiating device circuits with individual zone supervision, individual notification appliance circuit supervision, incoming and standby power supervision.
  - a. Include a control panel, manual pull stations, automatic fire detectors, audible devices, flashing lights, remote annunciator, remote control devices, conduit and wiring, connections to devices, outlet boxes, junction boxes, and other necessary material for a complete operating system.
  - b. The building shall have an emergency voice alarm communications system. The digitized voice message shall notify occupants that a fire condition has been reported. Provide emergency manual voice override.
  - c. The fire alarm control panel shall allow for loading or editing special instructions and operating sequences as required. The system is to be capable of on site programming to accommodate and facilitate expansion, building parameter changes or changes as required by local codes. Software operations are to be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.
2. To accommodate and facilitate job site changes, initiation circuits shall be individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching circuit or a alarm verification circuit.



3. Panels and peripheral devices shall be the standard product of a single manufacturer (unless otherwise specifically noted) and shall display the manufacturer's name on each component. The materials specified under this section are those of Siemens Fire Safety, General Electric/Edwards Systems Technology (EST), and Honeywell/Notifier and constitute the type, product quality, material, and desired operating features.
4. If equipment of another manufacturer is submitted for approval, the contractor shall state what, if any, specific points of system operation differ from the specified points of the system operation. This differentiation report is to reference every paragraph of this specification. The following manufacturers are pre-approved for bidding purposes on this project:
  - a. Siemens Fire Safety
  - b. Honeywell/Notifier
  - c. General Electric/Edwards Systems Technology (EST)

#### 1.06 OPERATION

1. Provide system with the following operation and control features:
  - a. Alarm reporting to remote supervising station (coordinate exact requirements with the Owner or local Fire Department).
  - b. Alarm verification for automatic smoke detectors.
  - c. Subsequent alarm (second zone in alarm re-sounds the audible signals after silencing of the first alarm).
  - d. Interface with pre-action sprinkler systems.
  - e. Monitor emergency generator per NFPA 110.
  - f. Monitor Area of Refuge Emergency Call System (Section 260500).
  - g. Control of auxiliary services:
    - 1) Magnetic door holder release.
    - 2) Release of magnetic door locks.
    - 3) Close smoke dampers.
    - 4) Operation of automatic smoke vents.
    - 5) Elevator recall and shutdown from landing, machine room, and hoistway smoke and heat detectors, per ANSI A17.1.
    - 6) Close fire shutter doors and motorized fire-rated doors.
    - 7) Interface with kitchen hood suppression systems.
    - 8) Interface with building fuel gas control panels and valves.
  - h. Detector sensitivity, status, adjustment, and testing from the control panel and day/night sensitivity control.
  - i. Alarm initiation and bell activation from sprinkler flow switches.
  - j. Alarm initiation from smoke detector operated doors and smoke hatches.
  - k. Supervisory indication from sprinkler valve tamper switches, with ring back upon correction.
  - l. Electrical supervision of output control circuits.
  - m. System status reports consisting of hard copy, English-language printout, with time and date stamp, of system input and output activity.
  - n. Digital alarm communication to remote station via telephone line.
  - o. Digital Pocket Paging Interface.

2. Under normal condition the front panel shall display a "SYSTEM NORMAL" message and the current time and date.
3. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall sound steadily for alarm conditions and pulse for trouble and supervisory conditions.
4. The panel shall display the following information relative to the abnormal condition of a point in the system:
  - a. Custom location label (40 characters minimum)
  - b. Type of device (i.e. smoke, pull station, waterflow)
  - c. Point status (i.e. alarm, trouble)

These three characteristics relative to an abnormal condition of a point shall be displayed simultaneously.

5. Pressing the appropriate acknowledge button shall acknowledge the alarm or trouble condition. The acknowledge functions may be passcode protected. Systems not capable of password protected manual command operations shall provide key operated switches for these functions. Function key switches shall be keyed differently from any other keyed switches or locks used within the system.
6. After all points have been acknowledged, the LED's shall glow steady and the panel audible signal will be silenced. The total number of alarms, supervisory, and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be indicated. This feature shall be duplicated by the remote annunciator panel(s) with both the main fire alarm control panel and remote annunciator panel(s) responding the same way.
7. Alarm Silencing
  - a. Alarm silencing shall be duplicated by the remote annunciator panel(s) with both the main fire alarm control panel and remote annunciator panel(s) responding in like manner.
  - b. Should the "Alarm Silence" button be pressed alarm signals shall cease operation.
  - c. Signals shall not be silenced during alarm silence inhibit mode.
8. System Reset
  - a. The "System Reset" button shall be used to return the system to its normal state after an alarm condition has been acknowledged and cleared by authorized personnel. The display shall step the user through the reset process with simple English language messages. Messages shall provide operator assurance of the sequential steps (i.e.: "IN PROGRESS", "RESET COMPLETED", and "SYSTEM NORMAL") as they occur, should alarm conditions be cleared.

9. Fan Reset
  - a. The "Fan Reset" button shall be used to return the previously shutdown mechanical systems to their normal state after an alarm condition has been acknowledged and cleared by authorized personnel. The display shall step the user through the reset process with simple English language messages. Messages shall provide operator assurance of the sequential steps (i.e.: "FAN RESET IN PROGRESS", "FAN RESET COMPLETED", and "FAN SYSTEMS NORMAL") as they occur, should alarm conditions be cleared.
  
10. Function Keys
  - a. Additional function keys shall be provided to access status data for system points. As a minimum the status data shall include Disable/Enable Status, Verification Tallies of Initiating Devices, Acknowledge Status, etc.
  
11. History Logging
  - a. In addition to any required printer output, the control panel shall have the ability to store a minimum of three hundred (300) events in an alarm log plus a minimum of three hundred (300) events in a separate trouble log. These events shall be stored in a battery protected random access memory (RAM). Systems not having discrete alarm and trouble logging memory shall include an alternative supervised (eg: floppy drive, tape cassette, zip drive) historic recording method with battery backup. Real time and date shall accompany history event recording.
  
12. Walk Test with History Logging
  - a. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm.
  
13. Access Levels
  - a. There shall be a minimum of four (4) access levels. Passcodes shall consist of up to ten (10) digits. Changes to passcodes shall only be made by authorized personnel. Systems not capable of password protected manual command operations shall provide key operated switches for these functions. Function key switches shall be keyed differently from any other keyed switches or locks used within the system.
  
  - b. The following keys/switches shall have access levels associated with them:
    - Alarm Silence
    - System Reset
    - Set Time/Date
    - Manual Control

- On/Off/Auto Control
- Disable/Enable
- Clear Historical Alarm Log
- Clear Historical Trouble Log
- Walk Test
- Change Alarm Verification

14. Detection Operation

- a. Smoke sensors shall be smoke density measuring devices having no self contained alarm set point (fixed threshold). The alarm decision for each sensor shall be determined by the control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to the stored values.
- b. The control panel shall maintain a moving average of the sensors' smoke chamber value to automatically compensate (move the threshold) for dust and dirty conditions that could affect detection operations. The system shall automatically maintain a constant smoke obscuration sensitivity for each sensor (via the floating threshold) by compensating for environmental factors. The smoke obscuration sensitivity shall be adjustable to within 0.3% of either limit of the UL window (0.5% to 4.0%) to compensate for any environment.
- c. The system shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined value, a "DIRTY SENSOR" trouble condition shall be audibly and visually indicated at the control panel for the individual sensor. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. If a "DIRTY SENSOR" is left unattended, and its average value increases to a second predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control panel for the individual sensor. To prevent false alarms, these "DIRTY" conditions shall in no way decrease the amount of smoke obscuration necessary for system activation. The control panel shall be listed to automatically perform the calibrated test requirements of NFPA 72.
- d. The control panel shall continuously perform an automatic self-test routine on each sensor that will functionally check sensor electronics and ensure the accuracy of the values being transmitted to the control panel. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition with the sensor location at the control panel.
- e. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each sensor:
  - primary status
  - device type
  - present average value
  - present sensitivity selected \*
  - peak detection values \*
  - sensor range (normal, dirty, etc.)

\*Values shall be in "percent of smoke obscuration" format so that no interpretation is required by the operator.

- f. An operator at the control panel, having a proper access level, shall have the capability to manually control the following for each sensor:
    - clear peak detection values
    - enable or disable the point
    - clear verification tally
    - control a sensor's relay driver output
  - g. It shall be possible to program the control panel to automatically change the sensitivity settings of each sensor based on time-of-day and day-of-week (for example, to be more sensitive during unoccupied times and less sensitive during occupied periods). There shall be a minimum of five (5) sensitivity settings available for each sensor.
  - h. The control panel shall have the capability of being programmed for a pre-alarm or two-stage function. This function allows an indication to occur when, for example, a 3% sensor reaches a threshold of 1.5% smoke obscuration.
  - i. For increased smoke detection assurance, individually addressed smoke sensors shall be provided with alarm verification. Only a verified alarm shall initiate the alarm sequence operation.
15. RS-232-C Output
- a. The Fire Alarm Control Panel shall be capable of operating remote CRT's and/or printers. The output shall be paralleled ASCII from an EIA RS-232-C connection.
16. Digital Alarm Communication
- a. Provide a digital communicator mounted in the FACU capable of transmitting an alarm to a remote central supervising station via two monitored telephone lines. The communicator shall supervise both telephone lines, seize the lines, and send a signal on one or both lines without the need of any additional equipment. If one line fails for more than 90 seconds, transfer to the remaining line occurs or if both lines fail, a local trouble alert signal sounds and an auxiliary relay contact alerts the BMS.
  - b. Provide a minimum of four (6) supervised channels, field configurable as either voltage inputs, active high or low inputs, or contact closure inputs programmed as follows:
    - 1) Channel 1 Manual Pull Station
    - 2) Channel 2 Automatic Alarm
    - 3) Channel 3 Waterflow Alarm
    - 4) Channel 4 Supervisory Activation

- 5) Channel 5 Trouble Activation
- 6) Channel 6 Alarm (Undefined) , CO, etc.

- c. Provide an auto-test feature, 24-hour programmable, to a central station at a preset time including a manual test override and a ring detector for one call downloading/remote programming with remote PC software.
- d. Provide 6-channel digital communicator by Silent Knight Model 5104 with Model 5230 LCD Annunciator/Keypad Programmer, Model 5561 Downloading Software/Modem Kit and Model TIK-512 Telephone Interface Kit, EST MODCOM, or approved equivalent.

17. Building Management System (BMS)/Temperature Control System Interface

- a. The FACU shall be capable of transmitting trouble and alarm signals to the Owner's BMS. Coordinate with Section 230923 and provide any interfaces, modules, or contacts to communicate with the BMS.

1.07 ALARM SEQUENCE

- 1. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch is to be as follows:
  - a. Audible alarm notification appliances shall sound a digitized tone and voice message until silenced by the alarm silence switch at the control panel or remote annunciator panel(s).
  - b. Visual alarm notification appliances (xenon strobes) shall display a continuous pattern until extinguished by the Alarm Silence Switch.
  - c. Doors normally held open by door control devices shall release.
  - d. A supervised signal to notify an approved central station shall be activated. To accommodate and facilitate job site changes the type of "city connection circuit" is to be on site configurable to provide either a "reverse polarity", "local energy", "shunt" or dry contact connection.
  - e. Air handling systems (supply and return) larger than 2000 cfm, shall be automatically shutdown. Other systems and equipment shall also be shut down as indicated on the plans.
  - f. Alarms shall be displayed on the panel display. The alarm LED shall flash on the control panel until the alarm has been acknowledged at the control panel. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone after acknowledged shall flash the alarm LED on the control panel and the panel display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote annunciator until acknowledged.

- g. Dry contact outputs from the fire alarm control panel (FACU) shall disable gymnasium sound, projection and house lighting systems upon any alarm condition. Gymnasium sound and projection systems shall be silenced and disabled to allow audiences to understand the alarm message. Gymnasium lighting levels shall return to egress brightness for safe evacuation.
  - 2. The alarm activation of any elevator lobby, hoistway, or machine room smoke or heat detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:
    - a. If the alarmed detector is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
    - b. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the pre-determined alternate recall level as determined by the local authority having jurisdiction.
    - c. The activation of any heat detector in an elevator hoistway or machine room shall automatically disconnect power to the elevator motor via addressable relay contacts activating the elevator feeder shunt-trip circuit breaker or fused switch (refer to drawings) after the elevator has returned non-stop to the designated level. The shunt trip shall not be activated until the elevator car is at the designated level and doors opened. This contractor shall coordinate programming of time delay with elevator contractor to allow elevator recall prior to shunt-trip.
  - 3. The control panel is to have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.
    - a. The activation of any standpipe or sprinkler valve tamper switch shall activate the system supervisory service audible signal, illuminate the LED at the control panel and activate the electric sprinkler fire bell outside the building. Provide differentiation between valve tamper activation and opens and/or grounds on fire alarm initiation circuit wiring. Fire bells shall be furnished and installed by Section 15750 and wired by this contractor.
    - b. Activating the Supervisory Service Acknowledge Switch will silence the supervisory audible signal while maintaining the Supervisory Service LED on indicating the tamper contact is still in the off-normal state.
    - c. Restoring the valve to the normal position shall cause the Supervisory Service LED to extinguish thus indicating restoration to normal position.
  - 4. Alarm and trouble conditions shall be immediately displayed on the control panel front alphanumeric display. If more alarms or troubles are in the system the operator may scroll to display new alarms.

5. The system shall have an alarm list key that will allow the operator to display alarms, troubles, and supervisory service conditions with the time of occurrence. This shall allow for the determination of not only the most recent alarm but also may indicate the path that the fire is taking.
6. The control panel shall be capable of supplying sufficient 24VDC power output to suit job conditions and expansion capability for system growth. Include a minimum of 20 percent spare capacity for 24 VDC notification appliance circuits.

1.08 SUPERVISION

1. The system shall contain a minimum of 2000 Class 'B' independently supervised initiation circuits so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
2. There shall be sprinkler supervisory initiation device circuits for connection of sprinkler valve tamper switches to perform the Supervisory Service Operation. Wiring methods which affect any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e.: sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). This independent initiation circuit shall be labeled Supervisory Service and shall differentiate between tamper switch activation and wiring faults.
3. Provide independently supervised and independently fused notification appliance circuits for audible alarms and flashing alarm lamps. Disarrangement conditions of any circuit shall not affect the operation of other circuits.
4. Auxiliary manual controls shall be supervised so that switches must be returned to the normal automatic position to clear system trouble.
5. Each independently supervised circuit shall include a discrete panel readout to indicate disarrangement conditions per circuit.
6. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.
7. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.
8. The System Expansion Modules shall be electrically supervised for module placement. Should a module become disconnected from the controls, the system trouble indicator must illuminate and audible trouble signal must sound.
9. The system shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.



1.09 POWER REQUIREMENTS

1. The control panel shall receive 120 VAC emergency power (as noted on the plans).
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 5 minutes of entire system alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. Battery charging and recharging operations shall be automatic.
3. Circuits requiring system operating power shall be 24VDC and shall be individually fused at the control panel.

1.10 ADDRESSABLE NETWORK

1. Communication with addressable devices: The system must provide communication with initiating and control devices individually. These devices are to be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:
  - a. Alarm
  - b. Trouble
  - c. Open
  - d. Short
  - e. Ground
  - f. Device Fail/or Incorrect Device
2. Addressable devices are to have the capability of being disabled or enabled individually.
3. Up to 60 addressable devices may be connected to a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.
4. Format: The communication format must be a poll/response protocol to allow t-tapping of the wire to addressable devices and be completely digital. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission protocol. Systems that do not utilize full digital transmission protocol (i.e. that may use time pulse width methods to transmit data etc.) will not be acceptable since they are considered unreliable and prone to errors.
5. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code digitally entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact.
6. Wiring Type, Distances, Survivability and Configurations: Wiring types will be approved by the equipment manufacturer. The system must allow up to 2,500 feet wire length to the furthest addressable device. Provide Class B Style 6 Signaling Line Circuit as defined by NFPA-72 communications for initiation and signal circuits.

7. For "campus" installations, where data/communication loops will run underground outdoors between buildings, provide manufacturer's recommended lightning surge suppression devices for each associated data loop. Locate devices at each point where loop(s) enters building(s) to protect associated system electronics.

#### 1.11 ONE-WAY VOICE COMMUNICATION

1. The system shall incorporate one-way voice communication and tone generating capabilities. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions. Provide two (2) amplifiers minimum and connect speakers to alternate circuits and arrange control equipment such that a loss of a portion of the wiring on a floor will not render more than 60% of the devices of each type inoperative, and the devices shall remain so connected to circuitry (i.e. by means of alternate circuits) as to maintain at least partial audibility/visibility throughout the entire floor.
2. A central audio control module shall be provided for the necessary alarm message/tone generation, main and remote microphone connections, music inputs, and mixer/pre-amplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure should a problem occur (i.e. main microphone trouble, tone trouble, etc.). Audio outputs shall have individual gain control.
3. A hand-held, push-to-talk microphone shall be provided, recessed within a protective panel-mounted enclosure. The microphone shall be a noise-canceling communication type with a frequency range of 200 Hz to 4000 Hz and shall be equipped with a self-winding five foot coiled cable. An LED indicator shall be provided to indicate the microphone push-to-talk button has been pressed and speaker circuits are ready for transmission. The microphone shall be supervised for disconnection.
4. An audio control switch module shall be furnished to provide manual access to audio operations for authorized personnel. The module shall include an "ALL Circuits" switch, "Aux Tone 1" switch, "Aux Tone 2" switch, tone generator stop switch, and "Audio Trouble Reset" switch. These switches and associated LED indicators shall be supervised for disarrangement or failure.
5. Audio power amplifiers shall be furnished with a self-contained filtered 24VDC power supply, transformer, and amplifier monitor circuits. The amplifiers shall provide a 25 Volt or 70 Volt RMS output with a frequency response of 120 Hz to 12,000 Hz. Provide sufficient amplification to operate system speakers simultaneously plus ten (10) percent spare capacity. Size amplifiers based on 2 watts minimum per speaker with 100% of speakers adjusted to the 2 watt tap setting.
6. Provide remote microphone/annunciator command sub-systems as shown on the plans shall to duplicate the manual voice transmission capability of the main fire alarm control panel. The sub-system microphone shall communicate only to the respective area speakers. The main FACU microphone shall override sub-system voice evacuation microphones and transmit the message throughout the main system and sub systems.

7. Automatic Voice Evacuation Sequence
  - a. The audio alarm signal shall consist of an alarm tone for a maximum of 15 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume. The alarm tones shall sound alternately until the alarm silence switch at the fire alarm control panel has been operated.
  - b. Audio alarm operations (speaker circuit selection and alarm tone/voice message timing variations) shall be activated by the system software so that any required future changes to the evacuation sequence can be facilitated by authorized personnel without any component rewiring.
8. Voice Evacuation Zones
  1. Provide a minimum of two (2) independent audio circuits from independent amplifiers to each voice evacuation zone as scheduled on the drawings.

## PART 2 - PRODUCTS

### 2.01 FIRE ALARM CONTROL UNIT (FACU)

1. Subject to compliance with requirements, provide Fire Alarm Control Units manufactured by one of the following:
  - a. Siemens Fire Safety Model FireFinder
  - b. Edwards System Technology Model EST 3 Audio
  - c. Notifier Model NFS-3030
2. Construction shall be modular with solid state, microprocessor based electronics. The FACU shall display only those primary controls and displays essential to operation during a fire alarm condition. Although the keypad/keyboard can be used for control (firefighter/emergency) of the entire system, it shall only be used for maintenance purposes. Keyboards or keypads shall not be visible or required to operate the system during fire alarm conditions.

A local audible device shall sound during Alarm, Trouble, or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound differently during each keypress to provide an audible feedback (chirp) to ensure that the key has been pressed properly.

3. Primary Keys & Panel Display

The Control Panel's display shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there should be keypad activity. The display shall support both upper and lower case letters. Lowercase letters shall be used for softkey titles and

prompting the user. Uppercase letters shall be used for System Status Information. A cursor shall be visible when entering information.

4. Equipment Enclosures

Provide cabinet(s) of sufficient size to accommodate the aforementioned equipment. The cabinet(s) shall be equipped with locks and transparent door panel(s) providing freedom from tampering yet allowing full view of the various lights and controls. Provide a separate enclosure for batteries larger than 15 ah. Enclosures shall be flush or semi-flush mounting unless otherwise indicated on the drawings.

2.02 PERIPHERAL DEVICES

1. Evacuation Signals, Voice Reproducing

Voice reproducing and visual alarm signals shall meet Americans with Disabilities Act (ADA) and UL Standard 1971 requirements shall have the following characteristics and capacities with provisions for speaker only and strobe only installations as required:

- a. Field selectable taps at 3db increments between 1/8 watt and 8 watts, driven at 25 volts rms or 70 volts rms, as shown on the drawings.
- b. Sound output rating of 96 db at full power tap.
- c. Visual intensity: Field-selectable 15/30/75/110 or 135/185 candela for wall-mounted units; field-selectable 15/30/75/95 or 115/177 candela for ceiling-mounted units; xenon strobe, synchronized repetition of 1-3 Hz, 0.2 second pulse duration, clear white light, white color housing, and back box. The LEXAN lens shall be pyramidal in shape to allow better visibility, labeled "FIRE" complying with ADA guidelines.
- d. Signals to be suitable for installation in audible only, audible/visual, and visual only in combinations described above and below:
  - 1) Wheelock ET-Series (Siemens S-HP series; Notifier SpectrAlert SP2 series; Simplex TrueAlert 4903 series; EST Genesis series). Provide mounting (wall and/or ceiling) as required by plans. Flush mount with 4-inch square outlet boxes; surface mount with manufacturer's factory finished backbox. Set candela ratings as indicated on plans. Appliances and associated wall plates shall be white.
- e. Unless otherwise indicated on the drawings, alarm speaker taps shall be set, as a minimum, to provide the following wattage levels for each location type of alarm speaker:
  - 1) Each floor alarm speaker: Provide 1 watt of input power.
  - 2) Each toilet alarm speaker: Provide 1/2 watt of input power.

- 3) Each mechanical room alarm speaker: Provide 2 watts of input power.
  - 4) Each stairwell alarm speaker: Provide 1/2 watt of input power.
  - 5) Each elevator cab alarm speaker: Provide 1/8 watt of input power.
2. Waterflow Alarm Bells – Furnished under Section 15750; power supply and installation and connection by this contractor.
  3. Door Holders: Magnetic door holders shall have a minimum holding force of 25 lbs. The door portion shall have an adjustable stainless steel pivotal mounted armature and contact plate with shock absorbing nylon bearing. Unit shall be capable of being either surface, flush, semi-flush or floor mounted as required. Door holders shall be UL-listed for their intended purpose. Operation: 24 volts unless indicated as 120 volts on drawings. Siemens Model SDH series, EST 1500 series, Notifier FM series or approved equivalent. Coordinate final locations and hardware with Architect.

### 2.03 ADDRESSABLE DEVICE TYPES

#### 1. General

The system control panel, over its two wire multi-drop channel, must be capable of communicating with the types of addressable devices specified below. Each device shall be electronically addressed, tested and programmed prior to installation using a UL-listed programmer/tester. Detectors shall be operational with relay bases, audible bases, and remote indicating LED's and programmable by the control panel. Devices shall be located as shown on the drawings.

2. Smoke Detector, Photoelectric: Pulsed infrared light source, photodiode, self-compensating for ambient temperature and humidity, in-place sensitivity readout from the control panel, two wire operation, LED alarm indication, UL (UROX) Listed for open area coverage. Notifier FSP series, Siemens Fire Safety FP-11 FirePrint series, EST Signature series, or approved equal.
3. Smoke Detector, Photoelectric, Duct Mounted: Analog HVAC duct smoke detectors listed for installation in air duct sampling housings for the detection of smoke in HVAC system ducts, with RF suppression and insect screen. Auxiliary SPDT relays or remote LED alarm indicators shall be installed where indicated. Provide remote LED alarm indicators and test stations in accessible locations for duct detectors. Notifier FSD series, Siemens Fire Safety AD-11XPR housing and Series 11 intelligent detector, EST Signature series, or approved equal.
4. Smoke Detector, Beam: Modulated infrared projected beam type with reflector; field selectable for sensitivities of 20, 35, or 60 percent obscuration, LED alarm indication on receiver, self-compensation for accumulation of dust and aging, internal tamper switch for cover removal, two wire operation and 15,000 square foot coverage. System Sensor Beam 200S, Honeywell Notifier FSB 200S, Siemens Fire Safety PBA-1191, General Electric Edwards Systems Technology or approved equal.

5. Heat Detector, Rate Compensated: Combination fixed temperature (135°F) and rate of rise, LED alarm indication, automatically restorable, 900 square foot coverage. Provide higher fixed-temperature-only, 200°F rated detectors where indicated on plans. EST Signature series, Siemens Fire Safety FPT-11 (for 135°F) or DT-200F (for 200°F), each with addressable CZM interface, Notifier FST series, or approved equal.
6. Fire Detector Bases, Universal: Low profile twist lock type with screw clamp terminals and self-wiping contacts, with EMI and RFI immunization. Bases shall be installed on 4" square or octagonal electrical outlet box. Where selective localized control of electrical devices is required for system operation, provide software programmed addressable relay integral to the base. The relay shall switch electrical loads, as indicated on the drawings for controlled release of smoke hatches and shaft vents, and for shunt-trip of elevator power disconnect. Detector bases shall be compatible with, and allow the installation of, detectors operating on the flame, ionization, photoelectric, or rate compensated heat principles of detection. Siemens Fire Safety DB-11 and DB-X11RS, Simplex 4098-9792, EST SIGA-RB, Notifier B224RB or approved equal.
7. Carbon Monoxide Detector: Low profile solid state sensor with hard-wired SPDT trouble and alarm relays, buzzer and visual status indicator, 24 VAC/DC, Macurco Model CM-15/15A or approved equal. Provide system interface module to provide addressable interface with FACU and auxiliary power supply as required.
8. Ultraviolet Flame Detector: Low profile line-of-sight solid state sensor with five (5) second alarm actuation delay using ultraviolet radiation principle of fire detection. Maximum five (5) detectors per detector circuit. [Provide security lock for tamper resistant installation where indicated on drawings.] Siemens Fire Safety Model DF-30 or approved equal.
9. Manual Station: Double action and identifiable by the master fire alarm control panel. Manufactured from high impact red Lexan with white raised lettering, mechanical latch upon operation, FACU-key operated manual reset. Flush or surface mounted as required, include manufacturer's back box, red baked enamel finish. Siemens Fire Safety MSI-20, EST Model SIGA series, Simplex 2099 series, Notifier NBG-12 or approved equal Manual stations shall be furnished with a tamper proof, clear Lexan polycarbonate shield and frame. An integral battery powered warning horn shall sound when shield is lifted. STI #STI-1000 series or pre-approved equal.
10. Remote Zone Module: Zone modules shall be used to interface normally open direct contact (non-addressable) devices to an addressable signaling line circuit. The module shall be identifiable by the master fire alarm control panel and contain an on board LED alarm indicator. Mounting: standard 4-inch outlet box, flush, surface and weatherproof as shown for the area indicated.
11. System Interface Module: Interface modules shall be used to interface normally open direct contact non-addressable devices to an addressable signaling line circuit to monitor alarm, trouble, supervisory or security devices. The module shall have Form C programmable control contacts for the management of specified electrical loads as shown on the drawings. The module shall be identifiable by the master fire alarm control panel and contain an on board LED alarm indicator. Mounting: standard 4-inch

outlet box, flush, surface and weatherproof as shown for the area indicated. Siemens Fire Safety TRI-B6 series, Notifier FMM-1, EST Signature series, or approved equal.

12. **Supervised Control Module:** Control modules shall be used to supervise relays, contactors, audible signal circuits, visual signal circuits, distributed speaker circuits and two way fire fighters communication circuits. Controlled circuits shall be power limited at 1.5 amperes.  
The module shall be identifiable by the master fire alarm control panel and contain an on board LED alarm indicator. Mounting: standard 4-inch x 2-inch deep or double gang x 3-inch deep outlet box, semi-flush or surface.
13. **Controllable Relay Module:** Controllable relay modules shall be used to provide auxiliary control of building functions such as door holder release, elevator capture, smoke control, lock release, shunt trip, etc. Each relay shall be supervised and include one set of SPDT contacts rated at 2 amperes, 30 VDC/120 VAC resistive minimum. Siemens Fire Safety CRM-4, EST Signature series, Notifier FCM-1 series or approved equal.
14. **Control Relay:** Provide remote relays where required for relay contact requirements above the approved rating of addressable relay modules for remote control of fans, dampers, door releases, motor controls, or status feedback. Relay shall be SPDT contacts rated at 10 amperes, 24 VDC/115VAC. A red LED shall indicate the relay is energized. PAM series or approved equal.

#### 2.04 REMOTE ALPHANUMERIC ANNUNCIATORS

1. Where shown on the plans, provide supervised, remote alphanumeric annunciators with features and characteristics as follows:
  - a. Any activity supported at the main control panel shall be enabled at the remote annunciator.
  - b. Active poll response communications with the master fire alarm control panel using the local system communications network.
  - c. Minimum 80 character alphanumeric display for fire alarms, supervisory reports, and system troubles. The number of characters shall mimic the number of characters on the main panel display.
  - d. Individual fire alarm, supervisory, security and trouble acknowledge momentary switches and power "ON", each with LED indicators showing acknowledgement status by flashing and steady states.
  - e. Remote paging capability consisting of dynamic push to talk microphone with enclosure.
  - f. Scroll switch for the alarm display. Switch shall enable scrolling backward or forward through the alarm queue.

- g. Integral audible signal with audible signaling silence switch with LED indicating the state of the evacuation signals.
- h. Key menu driven keypad for the entry of passcodes, request for reports, setting time, and bypassing points.
- i. Twelve software programmable function key commands. These commands shall be capable of utilizing any and system logic functions resident within the system programming or of being an input into any of the logic functions.
- j. Locked cabinet, factory finished enamel with viewing window. Cabinet shall not exceed 14 inches in width and height, or 3.5 inches in depth.
- k. The annunciator shall be capable of supporting a supervised system printer, system CRT control terminal with keyboard or system color graphics alarm display terminal.
- l. Remote annunciator shall be Siemens Fire Safety remote command center #RCC series or EST LSRA-C or 3-LCDANN series, Notifier FDU 80 series, or Simplex 4603-9101 or approved equal.

#### 2.05 VIDEO DISPLAY TERMINAL

- 1. Provide a minimum 17" digital LCD terminal for a color graphics visual display and audible alert of changes in status of the system. Displays shall be annotated with current time and date. Monitor shall be UL listed.
- 2. Terminal enclosure shall be suitable for placement on a desk or tabletop, and shall operate on 120 VAC.
- 3. A detachable keyboard shall be included for system control.
- 4. Provide necessary interconnecting cables, connectors, and interfaces.
- 5. Locate VDT in the Building Engineer's office.

#### 2.06 DESKTOP PRINTER

- 1. Desktop printer shall be standard carriage, 80 characters per line, serial or parallel interface, supervised circuitry, UL listed, using standard pin-feed paper. Enclosure shall be suitable for placement on a desk or tabletop. Printer shall operate on 120 VAC.
- 2. Provide necessary interconnecting cables, connectors, and interfaces.
- 3. The printer shall automatically provide a hard-copy printout of changes in system status, indicating the time, date, location, device identification, and type of occurrence.
- 4. Locate printer in the Building Engineer's office.



2.07 WIRING

1. Fire alarm cable shall be "Teflon" jacketed, or the equivalent in ¾" C, conforming with the requirements for type FPLP "Power-Limited Fire Protective-Signaling Circuits," having a temperature rating of 60°C or higher, solid conductor insulation with a minimum average thickness of 7 mils, protected with a sheath and an outer jacket of 15 mils minimum, colored red. Cable shall be labeled for its entire length per UL 1424, size, voltage, and temperature rating.
2. Provide and install two #14 AWG minimum twisted pair, shielded for initiating device analog loop circuits.
3. Provide and install two #14 AWG minimum twisted pair, shielded for strobes, and non-shielded for [speakers and] analog audible device loop circuits.
4. Provide and install two #14 AWG minimum twisted pair, non-shielded for each waterflow alarm bell.
5. Provide and install two #18 AWG minimum twisted pair, non-shielded for warden telephone circuits
6. Verify conductor sizes and quantities with system manufacturer, prior to installation.
7. Increase wire size to accommodate voltage drop per manufacturer's recommendations. Design circuits to a maximum of 75% rated capacity to accommodate future device additions and sound level changes. Do not exceed manufacturer's maximum circuit lengths.

2.08 ISOLATOR MODULE

1. Provide isolator modules to automatically isolate wire-to-wire short circuits on a signaling line circuit (SLC) loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop after each 25 initiating devices and control points or a lesser number where recommended by the manufacturer. Modules must be readily accessible (not above ceiling) and clearly labeled.
2. Operation: Isolator modules shall operate such that if a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
3. Mounting: The isolator module shall mount in standard 4-inch square, 2-1/8" deep electrical boxes. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

4. Labeling: Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built system drawings.

#### 2.09 SPARE PARTS

1. Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping or tagging. Furnish the following spare parts, in the quantities listed:

Automatic Detectors of each type installed: [5]

Manual pull stations and pre sounding covers: [8]

Fire alarm notification devices of each type: [5]

Fuses for each fused circuit: [10]

Lamps for each lamp type furnished: [10]

Sets of keys, wrenches or special tools required to gain access to lockable equipment: [5]

2. In addition to the above, the FACU shall have sufficient internal space for the future addition of at least 5 additional multiplex loop cards and associated power supplies, hardware, etc.

### PART 3 - EXECUTION

#### 3.01 DESIGN AND INSTALLATION DRAWINGS

1. Show a general layout of the complete system including equipment arrangement. Verify dimensions and assure compatibility with other systems interfacing with the fire alarm system.
  - a. Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification.
  - b. For addressable alarm initiation devices, the system identifier shall be, as minimum, the system address for that device. Signals shall be sequentially numbered as the address of the controlling module. Provide additional identification labels, room name, number and area, etc., as required by the Owner and coordinated with the Owner prior to final programming of the FACU.
  - c. Indicate on the point to point wiring diagrams, interconnecting wiring within the panel between modules, and connecting wiring to the field device terminals.

#### 3.02 INSTALLATION

1. Field installer shall be NICET Level 3 certified in Fire Protection Engineering Technology, Fire Alarm Systems. Perform work in accordance with the requirements of NFPA 70, NFPA 72, and other requirements of local authority having jurisdiction.

2. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
  - a. Use clamping devices for attaching to structural steel, or when clamping is impractical, obtain written authority to weld or to drill.
  - b. Fasten equipment to concrete or masonry with expansion anchors.
  - c. Fasten equipment to drywall by screws into studs, and to metal wall panels by weld studs, bolts or self-tapping metal screws.
  - d. Do not install conduit raceways and boxes in positions that interfere with the work of other trades.
  - e. Attach nameplates on panels or other components as specified.
3. Install equipment and devices where indicated; refer to architectural drawings for exact locations and mounting heights.
4. Refer to HVAC drawings and specifications (Division 23) for exact locations of duct-mounted smoke detectors. Coordinate with appropriate trade for the cutting of ducts and mounting of housings and sampling tubes.
5. Provide remote indicators for concealed smoke detectors and install in a readily visible location as close as possible to the location of the associated detector, either flush wall mounted 5'-0" AFF, or flush ceiling mounted. Provide remote indicators for duct smoke detectors located outside of mechanical equipment rooms. Coordinate exact mounting locations of remote indicators with architect in field.
6. Smoke detectors shall not be located in a direct air flow nor be closer than three (3) feet from an air supply diffuser or return air opening. Increase separation as required per NFPA 72.
7. Conduit requirements for running of multi-conductor fire alarm and voice communications system wiring shall be as follows:
  - a. Multi-conductor cables may be installed without raceway protection where cable is protected by building construction, or located 8 feet or greater above the finished floor and not subject to physical tampering or hazard in accordance with NYCBC RS17-3. Support multi-conductor cables as required by RS17-3.
  - b. Wiring shall be run in EMT in all cases where stubbed down into walls and run below 8 feet.
  - c. All wiring within mechanical and elevator equipment rooms shall be run in raceway.
  - d. Exposed raceways run within 8' of finished floor in garages, mechanical rooms, elevator machine rooms, loading docks and elsewhere where subject to mechanical damage shall be rigid galvanized steel conduit.

- e. Flexible metal conduit, up to 36 inches in length, shall be permitted for final connections to initiating and notification devices.
  - f. In any suppression and extinguishing system activated by automatic fire detection, including, but not limited to, pre-action sprinkler, deluge sprinkler, clean air agent, range hood, CO<sub>2</sub>, and/or dry chemical, multi-conductor cables shall be installed in rigid galvanized conduit or EMT, in accordance with the requirements of locations in item c above.
  - g. Power shall not be installed in raceways with low voltage wiring.
  - h. Raceway shall have a maximum 40% fill. Refer to Section 260500 for raceway and installation requirements.
  - i. Telephone wiring between digital alarm communicator and telephone system shall be run in rigid galvanized steel conduit.
8. Provide a separate raceway system for fire alarm wiring Power shall not be installed in raceways with low voltage wiring. Raceway shall be electrical metallic tubing (EMT), minimum ¾-inch size, maximum 40% fill and as indicated on drawings. Refer to Section 260500 for raceway and installation requirements.
9. Unless otherwise indicated, backboxes shall be recessed, and conduits and cable shall be concealed.
10. "Fire alarm system" decal shall be applied to junction box covers.
11. Each conductor shall be identified with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
12. Splices shall be made using solderless connectors. Connectors shall be installed in conformance with the manufacturer's recommendations.
13. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
14. Permanently label or mark each conductor at both ends with permanent alpha-numeric wire markers.
15. Use a consistent color code for fire alarm system conductors throughout the installation.
16. Smoke detectors shall not be installed until final construction clean-up has been completed. Replace detectors contaminated during construction. Caution: Covers supplied with smoke detector head do not provide protection against heavy construction dust, spray painting, etc., and shall not be used for that purpose. Covers are suitable only during final, minor clean-up or touch-up operations.
17. The contractor shall clean dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

18. The manufacturer's authorized representative shall provide on-site supervision of installation. Power shall not be applied to the system until a manufacturer's factory trained representative is present.
19. Identify individual devices. Assign each a unique number as follows, in sequence starting at the FACU: (Addressable Loop # -- Device # -- Room/Space #). Show on the record drawings, and also permanently mount on each device's base so that the identification is readable standing on the floor below without having to remove the device. Exception: For detectors with housings (air duct, projected beam, air sampling) apply the identification to a suitable location on the exterior of the device housing. Addressable device descriptors shall utilize room/space designations and numbers that will be used by the facility after occupancy. Descriptors shall be approved by the architect.
20. For each duct/plenum detector provide remote alarm indicator lamp/test switch installed in the nearest corridor or as shown on plans. Identify each location by an engraved label affixed to the wall or ceiling.
21. The contractor shall provide up to three fire alarm system reprogramming revisions as directed by the Owner.
22. Provide supervisory alarm wiring from the fire pump controller to the fire alarm system. Supervisory alarms to be wired are: power failure alarm, phase reversal alarm, and pump running alarm. Coordinate all alarm contact voltages, ratings, and types (NO/NC) with the equipment being supplied.
23. The fire alarm voice evacuation system messages shall be as approved by the architect and custom messages shall be provided as directed.
24. Label locations of duct smoke detectors to indicate "Duct Smoke Detector Access".

### 3.03 FIELD QUALITY CONTROL

1. General Testing
  - a. Intelligent analog devices shall be tested for correct address and sensitivity using test equipment specifically designed for that purpose. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the system address, initials of the installing technician and date.
  - b. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
    - 1) A systematic record shall be maintained of readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.

- 2) The acceptance inspector shall be notified before the start of the required tests. Items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
  - 3) Test reports shall be delivered to the acceptance inspector as completed.
  - c. Test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the contractor. The following equipment shall be a minimum for conducting the tests:
    - 1) Ladders and scaffolds as required to access installed equipment.
    - 2) Multi-meter for reading voltage (current and resistance).
    - 3) Intelligent device programmer/tester (if required to set device addresses).
    - 4) Laptop computer with programming software for any required program revisions.
    - 5) Two way radios, flashlights, smoke generation devices and supplies.
    - 6) A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
    - 7) Decibel meter.
    - 8) Spare printer paper – 2000 sheets.
  - d. In addition to the testing specified to be performed by the contractor, the installation shall be subject to test by the acceptance inspector.
  - e. System wiring: Fire alarm circuits shall be tested for continuity, grounds, and short circuits.
2. Acceptance Testing
- a. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the manufacturer in accordance with NFPA 72, and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of system components, circuits, and programming.
  - b. The contractor shall prepare a program matrix referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.

- c. A complete listing of device labels for alpha-numeric annunciator displays and logging printers shall be prepared by the contractor prior to the ATP.
- d. The acceptance inspector shall use the system record drawings in combination with the documents specified under paragraph 3.01 during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or input and output functions. The items tested shall include but not be limited to the following:
  - 1) System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
    - a) Open, shorted and grounded intelligent analog signaling circuit.
    - b) Open, shorted and grounded network signaling circuit.
    - c) Open and grounded conventional zone circuits.
    - d) Open and grounded signal and telephone circuits.
    - e) Intelligent device removal.
    - f) Primary power or battery disconnected.
    - g) Incorrect device at address.
    - h) Printer trouble, off line or out of paper.
  - 2) System evacuation alarm notification appliances shall be demonstrated as follows:
    - a) Alarm notification appliances actuate as programmed.
    - b) Audibility and visibility at required levels.
  - 3) System indications shall be demonstrated as follows:
    - a) Correct message display for each alarm input at the base building control panel and each remote alpha-numeric display and each video display terminal.
    - b) Correct annunciator light for each alarm input at each annunciator as shown on the drawings.
    - c) Correct printer logging for system activity.
- e. After the Contractor has completed his own acceptance test following the ATP procedure, and after the authorized fire alarm equipment representative has performed a 100% complete test of the system, an acceptance test of the fire alarm system will be conducted by the Contractor in the presence of the Authority Having Jurisdiction (AHJ) and as directed by the Owner or his authorized representative.
- f. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.

- 1) The contractor shall retest the system, correcting deficiencies and providing test documentation to the acceptance inspector.
  - 2) The acceptance inspector may elect to require the complete ATP to be preformed again if, in his opinion, modifications to the system hardware or software warrant complete re-testing.
- g. Before Final payment, the System Supplier shall turn over, to the owner, a disc copy and hard copy of the approved system custom program. Information shall be complete to allow for an alternate Factory Authorized Distributor to service, maintain, add, or delete devices as required.

### 3.04 SERVICES

1. The contractor shall warrant the entire system against mechanical and electrical defects for a period described in the contract general conditions. This period shall begin upon completed certification and test of the system or upon first beneficial use of the system, whichever is earlier.
2. Refer to specification 260000 3.8 for maintenance requirements.
3. The contractor or manufacturer shall offer for the owner's consideration at the time of system submittal a priced inspection, maintenance, test and repair contract in full compliance with the requirements of NFPA 72.
  - a. The services offered under this contract shall be performed at no charge during the first year and one half (18 months) after system acceptance and the owner shall have the option of renewing for single or multiple years up to five years at the price quoted upon completion of the warranty period.
  - b. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.
4. Furnish training as follows for a minimum of four employees of the system user:
  - a. Refer to specification section 283100 2.0 for videotaping.
  - b. Training in the receipt, handling and acknowledgement of alarms.
  - c. Training in the system operation including manual control of output functions from the system control panel.
  - d. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.



- e. The total training requirement shall be a minimum of 24 hours or as required by the Owner, conducted on three successive days, but shall be sufficient to cover the items specified.
- 5. Prepare and start systems as directed by the Architect.
  - a. Include services of a certified technician to supervise adjustments and final connections, if required by the local authority having jurisdiction, to include: speaker tap setting, strobe intensity, detector sensitivity and door release adjustment.

### 3.05 WARRANTY

- 1. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (2) year from the date of the completed and certified test or from the date of first beneficial use.
- 2. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72 guidelines.

### 3.06 EXISTING CONDITIONS

- 1. Where work consists of additions or extensions to replacing an existing system, prior to starting work, establish that system is in proper working order. If condition exists which prevents normal operation of specified additions and extensions, bring this fact to Architect's attention prior to doing work affecting existing system.
- 2. Where work is done without such notification, it shall be assumed that connections have been made to a working system, and performance requirements and guarantee will apply to entire system.
- 3. The existing building will be in operation continuously. Refer to notes on drawings, Section 260050, and elsewhere in this specification regarding system shutdowns.

END OF SECTION

SECTION 31 14 00 - STRIP AND STOCKPILE EXISTING TOPSOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 - General Requirements and Specific Requirements are to be considered as included as part of this section.

1.2 SECTION INCLUDES

- A. The Contractor shall strip, and stockpile existing topsoil in accordance with the plans, specifications and as directed by the Engineer.
- B. The Contractor shall be liable for any damage to property caused by topsoil moving and/or storage operations. All areas disturbed by construction shall be restored to their original condition, to the satisfaction of the Engineer.

1.3 RELATED SECTIONS

- A. Section 32 92 00 – Seed and Sod Lawn

1.4 PROTECTION OF UTILITIES

- A. Prior to the excavation of any area, the Contractor shall ascertain the location of all existing utility lines designated to remain, so that proper precautions may be taken not to disturb or damage any existing surface or subsurface utilities.
- B. Call Before You Dig: Contact Call Before You Dig Services (1-800-922-4455) prior to commencing any topsoil removal and earthwork operations.

The Contractor shall acquaint himself with the located utilities. Protect all utilities designated to remain within the area of the work. Any damage to existing facilities by reason of the performance of the work under this Contract will be the Contractor's responsibility and repaired at his expense in conformance with the applicable utility company and municipal requirements. Maintain existing systems in operation as required during installation of new work.

- C. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work.
- D. Protect: All existing improvements, utilities and pavements designated to remain. Excavations shall be protected and maintained as required.

- E. Protect: All benchmarks, monuments and property boundary pins. Replace if destroyed by Contractor's operations.

## PART 2 - PRODUCTS

- 2.1 EQUIPMENT: As selected by the Contractor.

## PART 3 - EXECUTION

### 3.1 METHOD

- A. Stripping: Topsoil shall be removed to a minimum depth of six inches (6") from all areas indicated and as directed by the Engineer. After review with and at the discretion of the Engineer, modifications to the topsoil removal depth may be made based on the actual depth of existing topsoil. Modification to the removal depth shall be confirmed and approved in writing by the Engineer.
- B. Storing: The Engineer shall select the location for storage of stockpiles, in cooperation with the Contractor. Topsoil shall not be stored under trees, unless unavoidable and approved by the Engineer. All topsoil shall be kept separate from other materials. Should the Contractor fail to do this, they shall furnish at their own expense, from lands outside of the work area, an equivalent amount of acceptable topsoil.
- C. Provide filter fabric fence and/or haybales surrounding the outside edge of stockpile to prevent erosion and migration of topsoil. Follow best management practices as indicated in Section 31 25 00 – Sediment and Erosion Control.
- D. Spreading: Conform to Section 32 92 00 – Seed and Sod Lawn.

## END OF SECTION

SECTION 31 14 05 - STRIP EXISTING CLAY INFIELD MATERIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 - General Requirements and Specific Requirements are to be considered as included as part of this section.

1.2 SECTION INCLUDES

- A. The Contractor shall strip, load and transport existing Clay Infield Material in accordance with the plans, specifications and as directed by the Engineer.
- B. The Contractor shall be liable for any damage to property caused by clay moving and/or storage operations. All areas disturbed by construction shall be restored to their original condition, to the satisfaction of the Engineer.

1.3 RELATED SECTIONS

- A. Section 32 18 23.15 – Clay Infield Surface
- B. Section 32 91 13 – Topsoil
- C. Section 32 92 00 – Seed and Sod Lawn

1.4 PROTECTION OF UTILITIES

- A. Prior to the excavation of any area, the Contractor shall ascertain the location of all existing utility lines designated to remain, so that proper precautions may be taken not to disturb or damage any existing surface or subsurface utilities.
- B. Call Before You Dig: Contact Call Before You Dig Services (1-800-922-4455) prior to commencing any topsoil removal and earthwork operations.

The Contractor shall acquaint himself with the located utilities. Protect all utilities designated to remain within the area of the work. Any damage to existing facilities by reason of his performance of the work under this Contract will be his responsibility and repaired at his expense in conformance with the applicable utility company and Town of Hamden requirements. Maintain existing systems in operation as required during installation of new work.

- C. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work.

- D. Protect: All existing improvements, utilities and pavements designated to remain. Excavations shall be protected and maintained as required.
- E. Protect: All benchmarks, monuments and property boundary pins. Replace if destroyed by Contractor's operations.

**PART 2 - PRODUCTS**

- 2.1 EQUIPMENT: As selected by the Contractor.

**PART 3 - EXECUTION**

**3.1 METHOD**

- A. Stripping: Clay Infield Material shall be removed to a minimum depth of six (6") inches from all areas indicated and as directed by the Engineer. After review with and at the discretion of the Engineer, modifications to the clay removal depth may be made based on the actual depth of the existing clay infield. Modification to the removal depth shall be confirmed and approved in writing by the Engineer.
- B. Storing: The Engineer shall select the location for storage of stockpiles, in cooperation with the Contractor. Clay material shall not be stored under trees, unless unavoidable and approved by the Engineer. All clay material shall be kept separate from other materials. Should the Contractor fail to do this, they shall furnish at their own expense, from sources outside of the work area, an equivalent amount of acceptable clay.
- C. Provide filter fabric fence and/or haybales surrounding the outside edge of stockpile to prevent erosion and migration of topsoil. Follow best management practices as indicated in Section 31 25 00 – Sediment and Erosion Control.
- D. Spreading: Conform to standards indicated in Section 32 18 23.15 – Clay Infield Surface.

**END OF SECTION**

SECTION 31 20 00 - BUILDING EARTHWORK

Part 1 GENERAL

1.01 GENERAL REQUIREMENTS

1. Provide all facilities, labor, materials, equipment, transportation, supervision, and related work necessary to complete the work specified in this Section, and as shown on the Drawings. This section applies to Building Earthwork only. See Related Sections for earthwork requirements beyond the building limits.
2. All work under this Section of the specifications shall be performed in accordance with Division 1, General Requirements.
3. All work shall be performed in accordance with applicable codes, permits and regulations, and the requirements of all local, state, and federal agencies having jurisdiction over the work.
4. The work of this Section includes, but is not limited to the following as related to building construction:
  - a. Excavating all types of materials to limits indicated or required, including soil, boulders, bedrock, utilities, foundations, pavements, debris, and any other materials and obstructions for below grade construction and other site improvements shown on the Drawings.
  - b. Providing a vapor retarder where indicated.
  - c. Providing, placing, moisture conditioning, compacting, and grading of fill and backfill materials to the specified limits and percent compaction required to construct foundations, slabs, and utilities.
  - d. Sheeting, shoring and dewatering of trenches and excavations.
  - e. Handling, segregating, and stockpiling materials utilized during the course of the work.
  - f. Removing from the site and legally disposing of excess materials and materials that are not suitable for on-site re-use in accordance with the Specifications.
  - g. Protecting existing utilities, structures and other facilities to remain during the work.
  - h. Providing plant, labor, equipment and materials and performing operations in connection with legally collecting, removing, handling and discharging groundwater and surface water encountered during construction.
  - i. Preventing trafficking of soil materials onto public roads or sidewalks, and providing street cleaning if required to remove such materials during the work.
  - j. Conducting all work in accordance with OSHA requirements and other applicable laws and regulations, and with the requirements of all federal, state, and local agencies and authorities having jurisdiction over the work.
  - k. Obtaining, paying for and complying with all required permits, licenses, and approvals prior to commencing the work.

1.02 RELATED WORK

1. Carefully examine the Contract Documents that affect the work of this Section, and coordinate to the extent required for proper performance of the work. Related work specified elsewhere includes:
  - a. Section 31 25 00 - Sediment and Erosion Control
  - b. Section 31 10 00 - Site Preparation
  - c. Section 31 23 16 - Unclassified Excavation
  - d. Section 31 23 23 - Borrow Soil Fill
  - e. Section 31 23 16.13 - Trenching
  - f. Section 31 23 13 - Formation of Subgrade
  - g. Section 31 66 13 - Helical Piles

1.03 REFERENCE STANDARDS AND DEFINITIONS

1. Refer to Section 01 33 00, Submittal Procedures, for submittal provisions and procedures.
2. Reference herein to any technical society, organization, group or body is made in accordance with the following abbreviations. Unless otherwise noted or specified, all work under this Section shall conform to the latest edition, as applicable.
  - a. ASTM: American Society for Testing and Materials
  - b. OSHA: Occupational Safety and Health Administration
  - c. CONNDOT: State of Connecticut Department of Transportation
  - d. RCRA: Resource Conservation and Recovery Act
  - e. Building Code: State of Connecticut Building Code, most recent version unless otherwise noted
  - f. Subgrade: The excavation level indicated consisting of undisturbed earth, compacted soil, or bedrock.
  - g. Trench: Excavation of any length where width at top is less than twice the depth and depth is greater than 5 feet. All other excavations shall be classed as open.
  - h. Contractor: Entity responsible for completing the work of this Section.
  - i. Geotechnical Engineer: Entity engaged by the Owner to provide construction phase services as related to the work of this section and other applicable sections (e.g., Section 31 66 13).

1.04 QUALITY ASSURANCE

1. The Owner shall retain a Geotechnical Engineer or Testing Agency (hereinafter referred to as "Testing Agency") to perform on-site observation and testing during various phases of the construction operations. The Testing Agency's presence does not constitute supervision or direction of the Contractor's work. Neither the presence of the Testing Agency, nor any observations and testing performed by him, nor any notice or failure to give notice shall excuse the Contractor from conformance with these Specifications or from defects discovered in his work or from the Contractor's responsibility for site safety including both persons and property.
2. All costs related to testing or replacement of nonconforming materials shall be paid for by the Contractor at no additional cost to the Owner.

3. The Testing Agency shall conduct and interpret the tests specified in this Section; shall state in each report whether or not the test specimens comply with all requirements of the Contract Documents; shall specifically note any deviations there from; and shall determine the suitability of materials to be used as fill.
4. Testing of Materials: The Testing Agency shall perform tests herein specified and additional tests as may be required and submit test reports to the Architect, including the following:
  - a. A gradation analysis on each type of borrow and on-site fill material by sieving in accordance with ASTM D422.
  - b. A moisture-dry density curve (Modified Proctor Test) in accordance with ASTM D1557C on each type of borrow and on-site fill material that is suitable for use to determine the maximum dry density and optimum moisture content.
5. Testing of Subgrade and Fill Layers: Subgrades and fill layers shall be approved by the Testing Agency before construction of any further work thereon. Test of subgrades and fill layers shall be taken as follows, or as determined appropriate by the Testing Agency
  - a. Footing Subgrades: For naturally deposited, undisturbed materials, subgrades may be approved by observation by the Testing Agency. Granular fill shall be tested as indicated below.
  - b. Each layer of fill placed shall meet the specified density indicated in 3.6D.2.
  - c. Perform one (1) field density test in accordance with ASTM D2922 on each lift of fill material placed for;
    1. every 25 lf or 200 sq ft below footings,
    2. every 50 lf or 500 sq ft along foundations and walls,
    3. every 2,500 sq ft below building slab but not less than 3 tests,
    4. every 5,000 sq ft below paved area but not less than 3 tests,
    5. every 10,000 sq ft below landscape areas, but not less than 3 tests
    6. every 100 lf of trench backfill.
6. Cooperate with the Testing Agency in the performance of the required tests.
7. If, based on reports of the Testing Agency and observations, the subgrade or backfill are found to be below the specified density or do not meet material specifications, additional compaction and proper materials shall be provided and at no additional expense to the owner.

#### 1.05 SUBMITTALS

1. At least ten (10) days prior to mobilizing to the site, the Contractor shall submit the following to the Testing Agency:
  - a. Proposed schedule, sequence, procedures and equipment for all earthwork including descriptions of all methods, operations and equipment proposed for excavation, sheeting and shoring, subgrade preparation, backfilling and compaction.
  - b. Details of compaction equipment.
  - c. Off-site disposal locations proposed to be utilized by the Contractor to receive materials that are not reused on-site, as further described in Sections 3.02.10 and 3.07.
  - d. Shop Drawings: Submit detailed shop drawings and calculations, to be reviewed by the Testing Agency, of applicable earthwork procedures and sequences



2. For each type of proposed fill material, the Contractor shall deliver to the Testing Agency's laboratory two (2) 50 lb bag samples for quality control testing from each borrow source or supplier, at least ten (10) days prior to when approval is required. No soil material shall be delivered to the site prior to submission of samples and other data as required herein, or without approval by the Testing Agency.
3. Prior to delivery to the site, submit chemical test data and source site data on fill materials to be imported to the site. All materials being imported to the site shall be newly-excavated borrow materials, free from contamination, oil and hazardous materials. Submit documentation judged sufficient by the Testing Agency that confirms that all imported materials are free of contamination. A letter, including backup data and chemical test results, from a Connecticut Licensed Environmental Professional will constitute suitable documentation that the material is clean. Source site data shall include, as a minimum:
  - a. Location, address, owner's name and telephone number, and nature of the source site, including a street map with the limits of the borrow pit property and the exact location of the borrow source on the site clearly illustrated.
  - b. Present and past usage of the source site and materials; description of abutting properties and their uses
  - c. Any previously existing report(s) associated with an assessment of the source site as relates to the presence of oil or hazardous materials.
  - d. Location within the site from which the material will be obtained.
4. In the event that site characterization of off site borrow sources indicates that soils are acceptable for use in the judgment of the Testing Agency, then chemical testing will not be required. It is anticipated that chemical testing will not be required for customarily utilized commercial borrow sources. However, if the site characterization data indicate materials could possibly be contaminated, chemical testing will be required as directed by the Testing Agency. The chemical testing shall be done as directed by the Testing Agency by the Contractor at no additional cost to the Owner.
5. A representative sample and literature of geotextiles to be used.
6. The Testing Agency will review the submitted information and make judgements about the suitability of the material. If the proposed materials are judged unacceptable, the Contractor shall identify and obtain materials from alternate source(s).
7. Certification For Examination of Site and Records: Before proceeding with the work, submit certification in a acceptable form, stating that careful examination has been made of the site, adjacent structures, existing structures, records of utility lines, test boring records, soil samples, subsurface exploration reports by the subsoil exploration consultant(s), the drawings, and specifications.

#### 1.06 COORDINATION

1. Prior to start of earthwork operations, the Contractor shall arrange an on-site meeting with the Engineer, Architect and Testing Agency for the purpose of establishing the Contractor's schedule of operations and reviewing observation and testing procedures and requirements.

2. As construction proceeds, the Contractor shall be responsible for notifying the Testing Agency at least three working days prior to the start of earthwork operations requiring monitoring or testing.
3. Cooperate with the Testing Agency in obtaining field samples and conducting field testing. Furnish incidental labor in connection with the required sampling and testing.

#### 1.07 SUBSURFACE SOIL DATA AND EXISTING SITE CONDITIONS

1. Examine the site, records of existing utilities and construction, record of test borings, subsurface exploration reports, and the soil samples and rock cores to determine conditions under which the work will be performed. Subsurface information is contained in the 29 June 2006 report entitled "Geotechnical Engineering Report, Eli Whitney CTHSS, Hamden, Connecticut" by Haley & Aldrich, Inc. The soil samples are available for review at the offices of Haley & Aldrich, Inc., 100 Corporate Place, Suite 105, Rocky Hill, Connecticut 06067-1803, Phone: 860-282-9400. The report is made available for information on factual data only and shall not be interpreted as a warranty of subsurface conditions whether interpreted from written text, test boring logs or other data. The test boring and test pit information represents subsurface conditions at the exploration locations at the time conducted.
2. The Contractor may perform additional explorations if the Contractor desires additional subsurface information, after obtaining Owner's permission, at no additional cost to the Owner.
3. If, during the course of construction operations, conditions differing substantially from those indicated in the report are encountered, promptly notify the Architect in writing, and do not disturb such conditions until directed. The Testing Agency will investigate such conditions, and, if it is determined that the conditions differ substantially from those that reasonably would have been anticipated from examination of the report and site, and that such conditions will necessitate a change in the work, he will recommend any required changes and adjustments. Oral or written communications with field personnel will not constitute acknowledgment of a differing subsurface condition.
4. Prospective bidders shall visit the site and observe existing conditions prior to submitting a bid.

#### 1.08 LINES, GRADES AND TOLERANCES

1. The Contractor shall be responsible for establishing lines, grades, and other survey control to complete the work. The Contractor shall be responsible for the maintenance and protection of the survey control reference points and location stakes. The Contractor shall employ a licensed Registered Land Surveyor or a Registered Civil Engineer, familiar with building construction, to establish lines and levels. The Contractor shall be responsible for the correct location of the proposed facilities, including locations and elevations and limits of excavations and fills.
2. Finished grades, contours, and elevations indicated on the Drawings describe final surface elevations for completed construction. Spot elevations shall take precedence over contours. The Contractor shall review the Drawing details and Specifications carefully to ascertain specific work limits and requirements for this Contract.

3. Construct finished grades to within ½ inch of the elevations indicated on the Drawings.
4. Maintain the moisture content of the fill material during placement within plus or minus two percent of the material's optimum moisture content per ASTM D1557.

1.09 PERMITS, CODES AND SAFETY REQUIREMENTS

1. Comply with all rules, regulations, laws and ordinances of the Municipality, State, Federal, and all other authorities having jurisdiction over the project site. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided by the Contractor without additional cost to the Owner.
2. Comply with the provisions of the Manual for Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration, United States Department of Labor.
3. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.
4. The Contractor shall not close or obstruct any street, sidewalk, or passageway without written permission from authorities having jurisdiction. The Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected thereby.
5. The Contractor shall comply with regulations of the State of Connecticut, Municipality, Environmental Protection Agency (EPA), and other agencies having jurisdiction over the work for disposal of dewatering discharge water.

1.10 EXISTING UTILITIES

1. Protect existing utilities remaining in service, including those remaining in service until after relocation, and relocated utilities are shown on the Drawings. Before excavating near any existing utilities, notify the utility owner, coordinate protective work and comply with the utility owners' requirements. Safeguard and protect from damage or movement any existing services, utilities and utility structures uncovered or encountered which are to remain in service.
2. Prior to beginning any excavation or fill placement, accurately locate and mark underground utilities and appurtenances in site area. Excavate to and expose utilities at locations, and conduct field surveys as necessary to determine locations of existing utilities.
3. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and public and private utility companies in keeping respective facilities and services in operation. Repair damaged utilities to the satisfaction of utility company.
4. Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by the Owner and then only after acceptable temporary utility services have been provided.

5. In case of damage or injury caused in the performance of work the Contractor shall, at his own expense make good such damage or injury to the satisfaction of, and without cost to, the utility Owner. Existing utilities damaged during the project work shall be repaired or replaced to their condition prior to commencement of earthwork operations.
6. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped as directed by the Architect. The location of such utilities shall be noted on the Record Drawings and reported in writing to the Architect

#### 1.11 PROTECTION OF PERSONS AND PROPERTY

1. The Contractor shall be responsible for the health and safety of all workers engaged in the work.
2. The Contractor is solely responsible for job site safety, and for the protection of all persons and property within and near the site from adverse impacts of the work
3. The Contractor shall protect all existing and newly constructed structures, utilities and all other facilities from damage caused by settlement, lateral movement, undermining, physical striking, washout and any other effects created by the Contractor's operations. The Contractor shall immediately notify the Architect of any damage or impacts caused to any facility, and shall immediately repair or replace such impacted facility in accordance with the direction of the Architect.
4. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
5. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
6. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
7. Where settling is measurable or observable at excavated areas, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

#### Part 2 PRODUCTS

##### 2.01 MATERIALS

1. Earth materials for use as fills shall be as described below. All soil materials proposed for importing to the site shall be clean, mineral soil materials from approved borrow sources, free of any contamination, as described in Section 2.01.7. Materials from construction sites or other non-commercial borrow sources shall not be imported to the site without prior approval of the Testing Agency.

2. Soil materials to be used as fill will be evaluated, based in part on information submitted by the Contractor to the Testing Agency. Materials may be rejected for use based on the results of the evaluation. Materials shall not be brought to the site without prior approval of the Testing Agency. Off site materials, which are rejected for use, if brought to the site, shall be immediately removed by the Contractor at his own expense.
3. Processed materials consisting of a mixture of two or more soil types (such as sand and either crushed stone, crushed concrete, or other crushed construction materials) are not acceptable for use as fill unless accepted by the Testing Agency.
4. On site soils will be allowed as common fill, if such materials meet the requirements of this Section and can be placed and compacted as specified herein, subject to acceptance by the Testing Agency. On-site soils will be allowed as fill below the floor slab except for the final 6 in. which shall be Compacted Granular Fill, if such materials can be placed and compacted as specified herein. On-site soils shall not be used to backfill below footings unless they meet Compacted Granular Fill requirements. On site soils shall not be removed from the site without prior approval from the Owner.
5. Common Fill: Common Fill shall consist of mineral sandy soil, free of organic materials, plastic, metal, wood, loam, trash, wood, snow, ice, frozen soil, clay and other compressible or deleterious materials. Common Fill shall have physical properties such that it may be readily spread and compacted without excessive weaving or instability. Common Fill shall conform to the following gradation

Sieve (ASTM D422)	Percent Finer by Weight
8-inch **	100
No. 4	20-90
No. 40	10-80
No. 200	0-30

"\*\*\*" when used in trenches within 2 feet of utilities, or within 2 feet of foundation walls the largest particle dimension shall be 3 inches. The size of the largest particle shall be less than 2/3 of the lift thickness.

6. Crushed Stone: Crushed Stone shall consist of inert, angular stone material derived from a stone quarry that is hard, durable, washed, and free of deleterious materials. Gradation shall conform to State of Connecticut Department of Transportation Form 816, M.01.01, No. 6 (3/4 in. size) as follows:

Sieve (ASTM D422)	Percent Finer by Weight
1 inch	100
3/4 inch	90 - 100
1/2 inch	20 - 55
3/8 inch	0 - 15
No. 4	0 - 5

7. Compacted Granular Fill: Compacted Granular Fill shall consist of suitable natural sand and gravel, free of organic material, debris, snow, ice, or other unsuitable materials and should be well graded within the following limits:

Sieve (ASTM D422)	Percent Finer by Weight
6 inch **	100
No. 4	20 - 80
No. 40	10 - 50
No. 200	0 - 8

\*\*\* when used in trenches within 2 feet of utilities, within 2 feet of foundation walls, or within 12 in. below slabs, the largest particle dimension shall be 3 inches. The size of the largest particle shall be less than 2/3 of the lift thickness.

8. Geotextile:
- a. Fibers used in the manufacture of geotextile, and the threads used in joining geotextiles by sewing, shall consist of long-chain synthetic polymers composed of at least 85 percent by weight polyolefine, polyesters, or polyamides. This shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. These materials shall conform to the physical requirements of 2.3 C below. Suitable materials include but are not limited to Amoco 4551, Mirafi 160N, and Nicolon S600.
  - b. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture, and extended ultraviolet exposure prior to replacement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.
  - c. Geotextile shall meet the following criteria:

MIN. REQUIREMENT	
Property	Class A
Grab Strength (lbs.)	160
Seam strength (lbs.)	140
Puncture strength (lbs.)	80
Burst strength (lb./in. 3)	290
Trapezoidal tear (lbs.)	50
Apparent opening size U.S. std. sieve	Greater than No. 30 sieve
Permeability (cm/s)	k fabric >k soil for all classes
Ultraviolet degradation at 150 hours	70% strength retained for all classes

2.02 USE OF MATERIALS

1. Common Fill: Use to backfill outside the Zone of Influence (as described in Part 3 Section 3.02.3) below building foundations. On-site materials, which meet the requirements of these Specifications, may be used as Common Fill.
2. Compacted Granular Fill: Use below footings, floor slabs, or other structural elements, for backfill against building wall and retaining walls, and as shown on the Drawings. On-site materials, which meet the requirements of these Specifications, may be used as Compacted Granular Fill.
3. Crushed Stone: Use for utility bedding as shown on the Drawings.
4. Geotextile: Geotextile shall be used: 1) at the locations shown on the Drawings, 2) other locations to prevent soil intrusion into drainage fill or drains, 3) to assist in stabilizing subgrades prior to placement of fill materials or structures, 4) to separate fine-grained materials from coarser-grained materials where the Testing Agency judges that migration of fine material into coarse material could occur. When used below foundations, ¾-inch crushed stone shall be entirely wrapped in geotextile. Other instances may also require the use of geotextile, as judged necessary by the Testing Agency.

Part 3 EXECUTION

3.01 STRIPPING, HANDLING, SEGREGATION AND STOCKPILING OF MATERIALS

1. During the course of the work, various quantities of materials will be accumulated and stockpiled for future re-use on-site or for off-site disposition. All excavated soils shall be classified by the Testing Agency prior to use on the site. The Contractor shall handle, segregate to prevent intermixing of different materials, protect, stockpile, and dispose of the excavated soils, as required.
2. Strip topsoil from areas to be excavated or filled, within proposed building limits and stockpile where it will least interfere with construction operations in accordance with Specification 31 10 00 "Site Preparation". Stockpiled topsoil shall be free of any subsoil, stones, clods of hard earth, plants or their roots, sticks or other matter not conducive to plant growth. Stockpiling shall be coordinated by the Construction Manager and shall comply with the requirements of Specification 31 25 00 "Sediment and Erosion Control".
3. Do not stockpile materials within any restricted areas shown on the Drawings.

3.02 EXCAVATION

1. Excavation shall include the removal of all materials encountered including earth, organic soils, boulders, pavement, utilities, obstructions, foundations, slabs, incidental structures and other materials to the elevations and limits required to construct the work shown on the Drawings. Excavations for footings shall be to naturally-deposited, inorganic bearing soils acceptable to the Testing Agency.

2. Excavation, subgrade preparation and backfilling shall be performed in-the-dry.
3. Where excavations are made to remove unsuitable materials beneath the planned building foundations or other structural elements, the horizontal limits of excavation shall be sufficient to place Compacted Granular Fill beneath structures below an envelope defined by 2 feet horizontally from the bottom the structural element at the bearing elevation, and down on 1H:1V slope to suitable bearing, defined herein as the Zone of Influence. If such fill limits cannot be achieved, the footing bearing level shall be lowered as needed to meet this requirement.
4. Where excavations are required to be made into the Zone of Influence below constructed foundations or structures, the Contractor shall design an excavation/bracing system to protect the soil within the Zone of Influence from loosening and becoming disturbed, and protect the structure from movement. The Contractor is responsible to protect existing facilities to remain from damage.
5. The Contractor shall control the grading so that ground is pitched to prevent water from running into excavated areas, damaging other structures, or leaving the site.
6. Where soil has been softened, frozen or otherwise disturbed, it shall be removed and replaced with suitable material at no additional cost to the Owner.
7. Exercise care to preserve materials below and beyond the lines of excavation. Where excavation is carried out, through error, below indicated grade or beyond the lines of excavation, backfill to the indicated grade and compact with acceptable materials at no additional cost to the Owner.
8. Authorized Additional Excavation: Where the Testing Agency determines that the soil encountered at the elevations shown is not capable of supporting the design load, or where unsuitable material is encountered, a Change Order will be issued to remove the unsuitable soil, fill with approved fill material and compact as hereinafter specified.
9. The Contractor shall shore, brace and/or slope excavations in compliance with OSHA. The Contractor shall be solely responsible for protection of existing or new facilities and for maintaining site safety in accordance with OSHA and other applicable regulations. Lateral excavation support systems shall be designed to retain and provide full support for adjacent soil, rock, structures, utilities, light fixtures, streets and other features and protect them from damage due to settlement, lateral movement, loss of ground, or any other causes related to this construction. In addition, the support system must be located to allow new construction to be completed. Lateral excavation support systems shall be designed for all temporary and permanent loading conditions to which it will be subjected.
10. Excavated materials unsuitable for reuse, and surplus excavated soil not used to fulfill requirements of the Contract, shall be legally removed and disposed of by the Contractor in accordance with regulations and requirements of municipalities or agencies having jurisdiction over the disposal, disposal sites and the route between the project and the disposal sites.



3.03 TRENCH EXCAVATION

1. Trench excavation shall include the removal and satisfactory disposal of materials encountered in the construction of building utilities.
2. Excavate soils to at least 6 inches below bottom of proposed utility lines, or deeper if required to place bedding materials shown on the Drawings.
3. When, in the opinion of the Testing Agency, unstable bearing soils are encountered at excavation subgrade, overexcavate at least 1 foot below the required excavation subgrade (or deeper as necessary) to a firm and stable subgrade. Place sub-bedding material consisting of Compacted Granular Fill, or Crushed Stone wrapped in non-woven geotextile, up to the bottom of the required pipe bedding material. This additional excavation and backfilling work shall be performed at no additional cost to the Owner.
4. Trench excavation shall be of sufficient width and depth at all points to allow pipes to be laid, and appurtenant work to be built in a workman-like manner and, when needed, to allow for sheeting and shoring, pumping and draining, and/or for removing and replacing any unsuitable materials.
5. The Contractor shall design, furnish, place, remove or leave in-place (as directed by the Testing Agency) all sheeting and bracing required to support the sides of trenches and other excavations needing lateral support, in accordance with OSHA.

3.04 DEWATERING

1. Provide, operate and maintain site and subsurface drainage and dewatering in an acceptable manner as required to complete the work throughout the course of the project.
2. Provide, maintain, and operate sumps, wells, pumps and related equipment, including stand-by equipment, of sufficient capacity to maintain excavations and trenches free of water 24 hours per day to enable all work to be conducted in-the-dry and to protect bearing surfaces from disturbance.
3. Water from excavations shall be disposed of in such manner as will not cause injury to public health, public and private property, existing work, work to be completed or in progress, roads, walks, and streets, or cause any interference with use of same by public. Under no circumstances shall concrete or fill be placed in excavations containing free water.
4. Construction will require excavation below water level in soil. The Contractor shall complete this work in-the-dry to maintain the undisturbed condition of the bearing soil.
5. Maintain groundwater in the bearing stratum at least 12 in. below lowest exposed subgrade level. If the dewatering methods have not been adequate and the bearing soils disturbed, remove disturbed soil as directed by the Testing Agency and replace with Compacted Granular Fill, crushed stone with geotextile, or lean concrete at no additional cost to the Owner.
6. Pumped groundwater and surface water runoff shall be filtered or initially pumped to a settling basin to remove suspended solids prior to discharge.

7. Discharge of pumped water, either surface water runoff or groundwater, shall be in compliance with discharge criteria contained in permits issued by governing agencies, and all legal requirements and regulations. Discharge into municipal systems shall not be conducted without prior approval of the Owner and obtaining required permits.
8. The dewatering system shall be capable of handling precipitation or surface water that enters the excavation in a manner that will prevent damage to new construction.

### 3.05 SUBGRADE PREPARATION

1. Prepare subgrades for structures in the presence of the Testing Agency. General requirements are as follows:
  - a. Footings shall bear on naturally-deposited sand or Compacted Granular Fill on the naturally-deposited sand. Existing fill and unsuitable material shall be removed from the zone of influence, as described in Part 3 Section 3.02.3.
  - b. Slab-on-grade shall bear on 6 in. of Compacted Granular Fill over naturally-deposited soils, new fill, or existing fill if judged suitable by the Testing Agency.
2. Remove vegetation, debris, loam, subsoil, trash, wood, unsatisfactory soil materials, obstructions, and deleterious materials from subgrade surfaces prior to fill placement. Subgrades that become soft or unstable due to inadequate dewatering, caving of the excavation, prolonged exposure, improper methods or other causes shall be re-excavated and re-prepared at no additional cost to the Owner.
3. Care shall be taken to avoid disturbance to natural inorganic soil or previously-placed fill subgrades in areas to receive fill or support future structures.
4. Upon completion of the required excavation, removal of disturbed or otherwise unsuitable material, and observation of the subgrade by the Testing Agency, proofroll the subgrade with at least four passes of a self propelled vibratory roller imparting at least 25,000 lbs of dynamic force deemed acceptable by the Testing Agency. In limited access areas, proofroll the subgrade using walk-behind vibratory drum roller or other equivalent equipment deemed acceptable by the Testing Agency.
5. In areas of weaving or soft or unstable soils, the soft materials shall be excavated and replaced with Compacted Granular Fill, Crushed Stone surrounded by geotextile, or other materials acceptable to the Testing Agency, at no additional cost to the Owner.
6. Prevent foundation and slab bearing subgrades from freezing and frost at all times, before and after placing additional fill or structures, by backfilling, use of insulated blankets or other approved methods. Soil subgrades in structure areas that freeze prior to concrete placement or further filling shall be thawed and recompacted, or the frozen soil removed and replaced with acceptable material, as directed by the Testing Agency.

3.06 PLACEMENT AND COMPACTION OF FILL MATERIALS

1. Fill Placement

- a. Prior to placement of fill deliver representative samples of each type of proposed borrow material to the Testing Agency for determination of suitability.
- b. Place and compact fill to the limits, of the types and in the manner as specified herein and shown on the Drawings. Unless otherwise specified or directed, material used for filling and backfilling shall meet the requirements specified under Part 2, Products. If material removed from the excavations does not meet requirements specified herein, provide material that does meet the criteria for backfilling.
- c. Slope and compact soil surfaces at the end of each day to provide for free surface drainage. Protect structures and pipes from damage during backfilling operations.
- d. Do not place fill containing frozen materials, snow or ice. Do not place fill, susceptible to freezing, in temperatures less than 32 degrees Fahrenheit. Do not place fill over frozen ground.
- e. Placement of fill shall not begin prior to observation and approval of subgrade conditions by the Testing Agency. The Contractor shall not place or compact fill material in the absence of the Testing Agency.
- f. Protect foundations, footings, waterproofing, utilities and other facilities during backfilling. Repair damage at no additional cost to the Owner.
- g. Backfill shall not be placed against walls creating an unbalanced condition until they are braced or have cured sufficiently to develop strength necessary to withstand, without damage, pressure from backfilling and compacting operations. At walls not designed to resist lateral earth pressures, maintain the difference in elevation of the top of the backfill on either side of the wall within 2 ft.
- h. If weaving or instability is observed during compaction, as judged by the Testing Agency, compaction efforts shall be discontinued until the Contractor stabilizes the subgrade. If required, the Contractor shall excavate and replace the unstable fill material with acceptable compacted material, at no additional cost to the Owner.
- i. Compaction shall be performed using approved vibratory compaction equipment. Compaction by puddling or jetting is prohibited.
- j. Control groundwater and surface run-off to minimize disturbance of material being placed. Dewater all subgrades prior to filling. Place all fill in-the-dry on stable, undisturbed subgrades.
- k. Place Compacted Granular Fill beneath structures below an envelope defined by 2 feet horizontally from the bottom the structural element at the bearing elevation, and down on 1H:1V slope to suitable bearing soil ("Zone of Influence").
- l. Provide suitable transition layers or non-woven geotextile, as required to prevent the migration of fine material into void spaces of coarser fill materials. Transition layers may consist of limited thickness of Crushed Stone (less than 6 inches thick), lean concrete or other methods approved by the Testing Agency. Crushed stone shall not be placed directly on soil subgrades beneath structures.

2. Trench Backfill

- a. Trenches shall be backfilled as soon as practicable.
- b. Utility bedding material shall be deposited in the trench, uniformly on both sides of the pipe, for the entire width of the trench to the springline of the pipe. The backfill material shall be placed by hand shovels, in layers not more than 6 inches thick in loose depth, and

each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe, free from voids.

- c. Trench backfill material above the utility bedding material may consist of the excavated soils, provided the excavated soils meet the Fill requirements for the intended area (e.g., below slabs and foundations), and can be readily spread and compacted. Peat and other organic soils shall not be used as trench backfill.
- d. All trench backfilling shall be done so as not to disturb the work at any time. The moisture content of the backfill material shall be such that proper compaction will be obtained. Puddling of backfill with water will not be permitted. Backfill within areas of pavement construction shall be made to grades required to establish the proper pavement base courses.
- e. Any trenches or excavations improperly backfilled or where settlement occurs shall be reopened, to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional expense to the Owner.
- f. During filling and backfilling operations, pipelines will be checked by the Testing Agency to determine whether any displacement of the pipe has occurred. If the inspection of the pipelines shows poor alignment, displaced pipe or any other defects, the condition shall be remedied in a manner satisfactory to the Testing Agency at no additional cost to the Owner.

3. **Compaction Equipment**

- a. Compaction equipment used to compact soil in open areas where space permits shall consist of vibratory rollers weighing at least 15,000 pounds applying a dynamic centrifugal force of at least 25,000 pounds, pneumatic compactors or other similar approved equipment with at least four passes and sufficient to provide a firm, stable subgrade and achieve the required compaction.
- b. Compaction equipment used in tight access areas shall consist of a walk-behind vibratory drum roller or other equivalent equipment having at least 5,000 pounds centrifugal force with at least four passes and sufficient to provide a firm, stable subgrade and achieve the required compaction.
- c. The Contractor shall use compaction equipment to obtain the specified compaction. In some cases, additional passes or heavier equipment may be required. The gradation of some materials on-site are such that field unit weight testing methods (sand cone and nuclear density equipment) may not provide representative compaction results. In these cases, the Testing Agency will use judgement in evaluating if the Contractor achieved the intent of the specification.

4. **Compaction Requirements**

- a. In-situ density testing should be performed during placement of compaction fill as a means of control. The nuclear in-place density test outlined in ASTM D2822 is required.
- b. The degree of compaction is expressed as the in-place dry unit weight as a percentage of the maximum dry density at optimum moisture content as determined by ASTM Test D1557 (Procedure C). Fill and backfill shall be compacted to at least 95% below footings and building slabs (Zone of Influence).
- c. In-situ density testing should be performed during placement of fill as a means of control. The nuclear in-place density test outlined in ASTM D2822 is required.

5. Moisture Control

- a. The fill should generally be within 2 percent of its optimum moisture content to facilitate compaction.
- b. Fill too wet for proper compaction shall be harrowed or otherwise treated to achieve compaction to the required density. Fill that cannot be dried shall be removed and replaced with drier material.
- c. Fill too dry for proper compaction shall be watered uniformly over the surface of the top loose layer. Sufficient water shall be added to allow compaction to the required density.
- d. In no case shall fill be placed over material that is frozen or shall frozen fill be used as backfill. No fill shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.
- e. Soils excavated from on-site may be too wet and may require moisture conditioning prior to reuse on-site in order to provide a firm, stable subgrade and achieve the specified compaction requirements.

6. Lift Thickness

- a. Place fill in uniform horizontal layers.
- b. Place fill in layers not to exceed 12 inches in loose lift thickness prior to compaction when utilizing heavy self-propelled vibratory compaction equipment, and 6 inches when utilizing hand-operated compaction equipment. Compact material with a minimum of 4 complete coverages per lift.

7. Protection of Fill

- a. Newly graded areas shall be protected from the actions of the elements and traffic. Damage to any lift caused by equipment, moisture entering the material, or any other cause shall be fully repaired by the Contractor prior to placement of overlying materials at no additional cost to the Owner.
- b. In the event of and prior to heavy rains, the Contractor shall suspend fill operations immediately and shall take steps to keep the site as well drained as possible. Fill operations shall not be resumed until the moisture content of the fill meets the requirements of the Specifications.
- c. The Contractor shall not disturb subgrade and underlying natural soils or compacted fill during excavation and filling operations. Methods of excavation and filling shall be revised as necessary to avoid disturbance of subgrade and underlying soils, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering, and other acceptable control measures. Disturbance shall be construed to include deterioration of fill, before or after placement and satisfactory compaction, due to the Contractor's operations, such as moving equipment, hauling trucks, etc.
- d. All excavated or filled areas disturbed during construction, all loose or saturated soil, and other areas that do not meet compaction requirements as specified herein shall be removed and replaced with suitable materials. Costs of removal of disturbed material and replacement shall be borne by the Contractor

3.07 IMPORTING AND EXPORTING MATERIAL AND MATERIAL DISPOSAL

1. It is anticipated that imported fill materials will be required to complete the work. The cost of providing all required materials shall be included in the base bid for the work.
2. A basic requirement of the work is to re-use the available on-site materials to the extent possible. Materials shall not be removed from the site without authorization by the Owner.
3. Materials that are not reused on-site shall become the property of the Contractor and shall be removed from the site and legally disposed of in accordance with federal, state, county laws, regulations and requirements, having jurisdiction over the work, the Contractor's disposal sites and the route between the site and the Contractor's disposal sites. All costs for legal off-site disposal of materials, including chemical and physical testing, shall be included in the base bid cost of the work.

Part 4 MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

1. All labor, materials and equipment associated with completing the work of this Section will not be measured but shall be paid for as part of the contract lump sum price.

**END OF SECTION**

SECTION 31 22 13 – FORMATION OF SUBGRADE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Preparation of subgrade beneath all curbs, pavements, foundations, natural grass athletic fields and lawn installation and as shown on the Drawings, or as ordered by the Engineer, and as specified herein. The work of formation of subgrade shall be performed at the plane coincident with the bottom most base or subbase material as shown on the Drawings.

1.3 RELATED WORK

- A. Section 31 23 16 – Earthwork
- B. Section 31 23 17 - Unclassified Excavation
- C. Section 31 23 33 - Trenching

1.4 QUALITY ASSURANCE

- A. Testing: Compaction tests may be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All re-testing in these areas shall be paid for by the Contractor.
- B. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Contract Documents and as directed by the Engineer and to allow adequate time for the proper execution of said tests.

1.5 PROJECT CONDITIONS

- A. West Nile Virus Precautions: To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.
- B. Dust Prevention: Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site in conformance with Form 816, Article 9.42.01 - 9.42.03 or Form 816, Article 9.43.01 - 9.43.03.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. As selected by the Contractor.

PART 3 EXECUTION

3.1 CONSTRUCTION METHODS

- A. Comply with Form 816, Article 2.09.03.

**END OF SECTION**



SECTION 31 23 16 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816 - 2004 or its latest edition and any supplemental specifications.

1.2 SUMMARY

- A. This Section includes the following: All excavating, not included under other sections, required for grading, trenching, paving, curbs, construction and reconstruction of structures, such as foundation structures, new underground fuel storage equipment or any other subsurface structures. The Contractor shall place, compact and dispose of excess excavated materials in accordance with the plans, specifications and directions of the Engineer.
  - 1. Unclassified Excavation shall include the removal of existing pavements, curbs, earth, boulders, buried timber, broken concrete pieces, existing foundations (e.g. concrete, concrete block), brick and other materials of any nature that may be encountered.
  - 2. The Contractor shall construct and place fill and backfill material in accordance with this specification.
  - 3. The Contractor shall saw cut existing pavements and/or saw cut existing curbs in accordance with the plans, specifications and direction of the Engineer.

1.3 RELATED SECTIONS

- A. Section 02 01 00 - Site Preparation
- B. Section 31 22 13 - Formation of Subgrade
- C. Section 31 23 17 - Unclassified Excavation
- D. Section 31 23 23 - Borrow Soil Fill
- E. Section 31 23 33 - Trenching
- F. Section 31 25 00 - Sediment and Erosion Control

- G. Section 32 11 23 - Processed Aggregate Base
- H. Section 33 46 23.16 - Broken Stone

#### 1.4 DEFINITIONS

- A. "Suitable Material" or "Acceptable Material"
  - 1. ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen material, vegetation and other deleterious material.
  - 2. Any mineral (inorganic) soil, blasted or broken rock and similar materials of natural or man made origin, including mixtures thereof, are considered acceptable materials.
- B. "Unacceptable Material" - ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH and PT.
- C. "Subgrade" - Surface upon which subbase, base, bedding material or topsoil is placed.
- D. "Subbase" - Select granular material which is placed beneath base material.
- E. "Base" - Fragmented stone material which is placed immediately beneath pavement or concrete structures.

#### 1.5 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All re-testing in unsatisfactory areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.

#### 1.6 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work in conformance with Form 816.

1.7 PROJECT CONDITIONS

- A. Contact Call Before You Dig services for Connecticut (1.800.922.4455) to locate underground utilities prior to commencing site preparation operations a minimum of 2 days before beginning any work at the site.
- B. West Nile Virus Precautions: To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill and Fill Materials: Any acceptable material.
- B. Subbase and Base Material: Conform to Form 816, Section M.02.02 - Subbase.
- C. Compacted Gravel Fill: Conform to Form 816, Section M.02.01 - Granular Fill and Section 2.1401 - 2.14.03.
- D. Compacted Granular Fill: Conform to Form 816, Section M.02.01 - Granular Fill and Section 2.1401 - 2.14.03.
- E. Bedding Material: Sand or sandy soil, all of which passes a 3/8" sieve, and not more than ten percent (10%) passes a No. 200 sieve.

2.2 SAND FOR SAND PIT

- A. Sand for filling sand pit shall comprise a sound, sharp, natural, clean, washed, well graded sand in compliance with ASTM Specification C33 and the following grading limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8" (9.52 mm)	100
No. 4 (4.75 mm)	95 - 100
No. 8 (2.36 mm)	80 - 100
No. 16 (1.18 mm)	50 - 85
No. 30 (500 um)	25 - 60
No. 50 (300 um)	20 - 30
No. 100 (150 um)	5 - 15
No. 200 (75 um)	0 - 10

2.3 BORROW SOIL FILL

- A. Conform to Section 31 23 23.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. The entire area of work shall be brought to the required lines and grades by excavation and filling. Excavated materials, acceptable in the opinion of the Engineer, shall be used in making embankments and filling the low areas of the work, and at such places as the Engineer may direct.
- B. Construct base course to required depths and elevations below all concrete pads and walks, building slabs and foundations, light pole foundations, and precast concrete post foundations.
- C. Construct subbase course to required depths and elevations below parking lot areas and concrete pads.
- D. Construct bedding course below all drainage and utility structures.
- E. Construct acceptable material below all lawn and landscaped areas.

**3.2 COMPACTION REQUIREMENTS**

- A. Compact soil to not less than the following percentages of maximum dry density according to ASTM 1557.
- B. Under foundations, concrete pads, building slabs, and pavements, compact the top 12 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
- C. Under concrete and stonedust walkways, compact the top 6 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
- D. Under lawn or unpaved areas: see Section 32 91 13 - Topsoil.

**3.3 EXCAVATION - MATERIALS**

- A. Subbase: All soft, boggy, clayey or other objectionable material below the proposed subbase shall be removed, and the area refilled with acceptable material. See Section – 31 23 23.

3.4 EXCAVATION - GENERAL

- A. Protect Structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Excavating for Foundations: All excavations shall be cut accurately to required lines and dimensions for work on drawings and shall be large enough to provide adequate clearance for the proper execution of the work.

Over-Excavation for Building and Retaining Wall Foundation Construction: Refer to Geotechnical Report, included herein, for limits and depths of over-excavation required under building and retaining wall foundations.

- D. Bottoms of Excavations: The Contractor shall level the bottoms of all excavations, to receive footings or other work supported on soil, accurately, to the lines and levels shown on the plans or as directed by the Engineer.
  - 1. Where excavation for a foundation has been carried below the indicated level by error on the part of the Contractor, he will be required to fill the space between the incorrect and required depth with concrete at no additional cost to the Owner.
- E. Boulders: The Contractor shall remove all boulders, stone or pieces of concrete, lumber, iron or other material that project above subgrade. Any stone larger than two (2) cubic feet in volume shall not be placed within two (2) feet of the finished surface.
- F. Provide sediment and erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water run-off or airborne dust to adjacent properties and watercourses, in accordance with the Sediment and Erosion Control Plan and as directed by the Engineer.
- G. Storage and Placement: All those excavated materials which in the opinion of the Engineer are suitable for backfill shall be stored or placed within the limits of the Contract, where directed by the Engineer.
- H. Surplus: All surplus materials and materials not suitable for backfill shall be removed from the site and disposed of by the Contractor. No additional payment will be made for this, but the cost thereof shall be deemed included in the price bid for "Earthwork".
- I. Shoring: Wherever necessary to maintain the banks of excavation in a safe and stable condition, the Contractor shall furnish and install temporary sheet piling or planks, braces and shores of good sound timber of adequate strength, and shall remove such piling or shoring as the foundation work progresses.

1. Sheeting and bracing of a type approved by the Engineer, shall be installed when the Contractor's employees are required to enter into excavations which exceed four (4) feet in depth.
  2. The foregoing shall include the construction and removal of sheeting and bracing, the excavation and maintenance of temporary ditches, and the furnishing and operation of pumps or other appliances needed to properly drain the work. No direct compensation will be made for this work, but payment therefore shall be deemed included in the price bid.
- J. Inspection: When the excavations have been carried to the required depth as shown on the drawings, the Contractor shall do no more work until after inspection by the Engineer, who shall order the foundation or other work to proceed, or further excavation, as the conditions indicate and no foundation or other work shall be done until the excavations have been approved by the Engineer.
- K. Utilities and Services: When any sewer, water, gas, electric or other utility service connections are encountered in the excavation operations, the service shall not be interrupted or disturbed by the Contractor unless called for on the plans and/or directed by the Engineer. It is the Contractor's responsibility to detect and protect existing utilities (to remain) from damage during construction. The Contractor shall locate buried utilities, to the best of his ability, using electronic probes, or other methods, prior to the start of excavation. The Contractor shall then proceed cautiously and perform hand excavation, as necessary, to protect the utility as directed by the Engineer, at no extra cost to the Owner. If a utility is inadvertently damaged, it is the Contractor's responsibility to restore that utility to operating condition, equal to that existing prior to damage. The Contractor shall remain at the site with the damaged utility until it has been restored and there is no danger to the public (i.e. exposed live electrical wires, etc.).
1. Should the Contractor need to cut off utilities or services during the performances of the work, he shall notify the Town Department or Utility Company owning or controlling services, to cut off these services.
  2. Any services cut off or interrupted by the Contractor's operations shall be restored at the Contractor's expense.

### 3.5 DE-WATERING

- A. Bailing and Draining: The Contractor shall furnish all materials, appliances and labor required to keep the site of the work free from water, ice and snow during construction.
- B. Provide all required channeling, piping, and pumping necessary to keep excavated areas clear of standing water. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area. Maintain site drainage at all times.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  2. Install a de-watering system to keep subgrades dry and convey ground water away from excavations. Maintain until de-watering is no longer required.
- D. Dispose with outfall to existing storm water systems. Prevent erosion or siltation of existing drainage systems by use of filter socks, other approved materials and State of Connecticut DEP best management practices.
- E. At completion of de-watering activities, remove temporary facilities and restore any damaged areas.

### 3.6 FILL

- A. Remove all vegetation, topsoil, debris, wet and unsatisfactory soil materials, obstructions, and deleterious materials from the ground surface prior to placing fills.
- B. Fill and Compacting shall be carried out as directed by the Engineer, and shall be constructed and compacted in successive horizontal layers not over 6 inches in depth. It shall be spread by a "Bulldozer", or other acceptable methods, and shall be thoroughly compacted by rolling with a self-propelling roller weighing not less than ten (10) tons and completed to the satisfaction of the Engineer. In places where the character of the material makes the use of this roller impracticable or where drains or other construction may be damaged, a lighter one may be substituted, or the area shall be compacted by vibratory tamping, all with the approval, and to the satisfaction of the Engineer.
- C. All hollows and depressions which develop during the process of rolling and compacting shall be filled with acceptable material, and the subgrade shall again be compacted. This process of filling and compacting shall be repeated until no depressions develop.
- D. Plow, strip or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
- E. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and re-compact to required density.

### 3.7 BACKFILL

- A. After inspection and approval of foundations and other work that is to be covered by backfill, the excavated voids shall be filled with clean excavated material and rammed solid.
- B. After areas and trenches have been excavated and structures constructed therein, the spaces around and above them shall be carefully backfilled with acceptable material. Backfill

shall be placed on both sides of structures to approximately the same elevation at the same time. All backfill shall be thoroughly tamped and rammed in place using rammers of a weight acceptable to the Engineer.

- C. Place backfill material in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Place backfill material evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- E. Backfilling around masonry manholes and catch basins shall not take place until the mortar has hardened and the possibility of movement is slight. Backfilling shall take place uniformly around all sides of the structure.
- F. When sheeting is being withdrawn, all cavities left thereby shall be filled with acceptable material, tamped in place so as to fill all voids thoroughly. Backfill inside of sheeting shall be placed before sheeting is removed.

### 3.8 UTILITY TRENCHES

- A. See Section 31 23 33 - Trenching.

### 3.9 SAW CUTTING

- A. All work shall be done by competent mechanics in an approved manner to the satisfaction of the Engineer.
- B. All saw cutting shall be carried out to the full depth of the pavement, curb or concrete walk to be cut. Saw cutting shall be done to accurate, neat and straight lines marked previous to commencement of work. Saw cutting shall be done with approved power saws specifically designed and manufactured for such a purpose. Compressor, backhoe or spade-cutting of the pavement will not be allowed.
- C. Workmen shall wear safety clothing and eye protection while operating saw equipment and shall be thoroughly familiar in the safe operation of the equipment.

**END OF SECTION**



SECTION 31 23 17 - UNCLASSIFIED EXCAVATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. All excavation, not included under other sections, required for grading, trenching, paving, curbs, construction and reconstruction of structures, such as subsurface structures or any other structures. The Contractor shall place, compact and dispose of excess excavated materials in accordance with the plans, specifications and directions of the Engineer. Unclassified Excavation shall be defined as the removal of below grade improvements such as existing asphaltic and concrete pavement and curbs, earth, boulders, buried timbers, broken concrete pieces, concrete and unit masonry foundations e.g. concrete block, brick and other materials of any nature, that may be encountered.
  - 2. The Contractor shall saw cut existing pavements and curbs in accordance with the plans, specifications and direction of the Engineer.
  - 3. Additional Unsuitable Excavation.

1.3 RELATED WORK

- A. Section 31 22 13 - Formation of Subgrade
- B. Section 31 23 16 - Earthwork
- C. Section 31 23 23 - Borrow Soil Fill
- D. Section 31 23 33 - Trenching

#### 1.4 SUBMITTALS

- A. Submit certification from an independent testing laboratory approved by the Engineer showing that all base, subbase and subgrade material comply with the specified requirements.
- B. Perform field tests or submit certification from an independent testing laboratory approved by the Engineer that all subgrade soils below proposed concrete foundations comply with the specified minimum allowable bearing capacity.

#### PART 2 - PRODUCTS

##### 2.1 DEFINITIONS

###### A. "Suitable Material"

- 1. ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen material, vegetation and other deleterious material.
- 2. Any mineral (inorganic) soil, blasted or broken rock and similar materials of natural or man made origin, including mixtures thereof, may be considered suitable material with the written approval of the Engineer.

###### B. "Unsuitable Material"

- 1. ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH and PT.
- 2. Any material containing vegetable or organic matter, such as muck, peat, or organic salt, or that contains man-made deposits of industrial waste, sludge or landfill.
- 3. Topsoil shall be considered unsuitable material for construction below pavements or structures.

C. "Subgrade" - Surface upon which subbase, base, bedding material or topsoil is placed.

D. "Subbase" - Select granular material which is placed beneath base material.

E. "Base" - Fragmented stone material which is placed immediately beneath pavement or concrete structures.

##### 2.2 MATERIALS

- A. All materials shall comply with Section 31 23 16.

PART 3 - EXECUTION

3.1 GENERAL

- A. The entire area of work shall be brought to the required lines and grades by excavation and filling. Excavation materials suitable in the opinion of the Engineer, shall be used in making embankments and filling the low areas of the work, and at such places as the Engineer may direct.
- B. Excavate to the limits shown on the Drawings to subgrade level. Compact subgrade level before placing fill, base or subbase materials.
- C. Construct subbase course to the required depths and elevations as shown on the Drawings below all pavements.
- D. Construct base course to the required depths and elevations as shown on the Drawings below all pavements, walks, steps, concrete slabs and foundations, and ramps.
- E. Construct bedding course below all drainage, sanitary and utility structures to the limits as shown on the Drawings.
- F. Place suitable material below all lawn and landscaped areas. No rocks larger than 2 inches in any dimension shall be placed within 4 inches of the finished grade.

3.2 COMPACTION REQUIREMENTS

- A. Compact soil to not less than the following percentages of maximum dry density according to ASTM 1557.
- B. Under structures, concrete slabs, steps and pavements, compact the top 12 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
- C. Under walkways, compact the top 6 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
- D. Under lawn or unpaved areas, compact the top 6 inches below subgrade and each layer of backfill or fill material at 90 percent maximum dry density.
- E. At a minimum, existing subgrade soils below proposed concrete foundations shall have an allowable bearing capacity of 2 tons per square foot. Subgrade material which can not meet this requirement shall be removed and replaced in accordance with Section 3.3 D of this specification.

3.3 EXCAVATION

- A. Protect Structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. Any damage to existing structures or utilities that occurs as a result of the Contractor's operations shall be corrected by the Contractor at no additional cost to the Project.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion and control measures prior to excavation to prevent erosion or displacement of soils and discharge of soil-bearing water run-off or airborne dust to adjacent properties and watercourses.
- D. Subgrade: All soft, boggy, clayey or other objectionable material as determined by the Engineer, shall be removed from below the proposed subgrade level and the area refilled with suitable material. Payment for "Additional Unsuitable Excavation" shall be on a "per unit" basis. The Engineer shall determine and approve the limits of additional excavation necessary.
- E. Boulders: The Contractor shall remove all boulders, stone or pieces of concrete, lumber, iron or other material that project above the subgrade level. Any stone larger than two (2) cubic feet in volume shall not be placed within two (2) feet of the finished surface.
- F. Excavating for Foundations: All excavations shall be cut accurately to required lines and dimensions for work on drawings and shall be large enough to provide adequate clearance for the proper execution of the work.
- G. Bottoms of Excavations: The Contractor shall level the bottoms of all excavations, to receive footings or other work supported on soil, accurately, to the lines and levels shown on the plans or as directed by the Engineer.

Where excavation for a foundation has been carried below the indicated level by error on the part of the Contractor, he will be required to fill the space between the incorrect and required depth with suitable material at no additional cost to the Owner.

- H. Storage and Placement: All those excavated materials which in the opinion of the Engineer are suitable for backfill shall be stored or placed within the limits of the Contract, where directed by the Engineer.
- I. Surplus: All surplus materials and materials not suitable for backfill shall be removed from the site and disposed of by the Contractor. No additional payment will be made for this, but the cost thereof shall be deemed included in the price bid.
- J. Shoring: Wherever necessary to maintain the banks of excavation in a safe and stable condition, the Contractor shall furnish and install temporary sheet piling or planks, braces

and shores of good sound timber of adequate strength, and shall remove such piling or shoring as the foundation work progresses.

Sheeting and bracing shall be designed by a Professional Engineer licensed in the State of Connecticut, and approved by the Engineer, and shall be installed when the Contractor's employees are required to enter into excavations which exceed four (4) feet in depth.

The foregoing shall include the construction and removal of sheeting and bracing, the excavation and maintenance of temporary ditches, and the furnishing and operation of pumps or other appliances needed to properly drain the work. No direct compensation will be made for this work, but payment therefore shall be deemed included in the price bid.

- K. Inspection: When the excavations have been carried to the required depth as shown on the drawings, the Contractor shall do no more work until after inspection by the Engineer, who shall order the foundation or other work to proceed, or further excavation, as the conditions indicate and no foundation or other work shall be done until the excavations have been approved by the Engineer.
- L. Bailing and Draining: The Contractor shall furnish all materials, appliances and labor required to keep the site of the work free from water, ice and snow during construction.
- M. Utilities and Services: Contact Call Before You Dig services for Connecticut (1.800.922.4455) to locate underground utilities prior to commencing site preparation operations a minimum of 2 days before beginning any work at the site. When any sewer, water, gas, electric or other utility service connections are encountered in the excavation operations, the service shall not be interrupted or disturbed by the Contractor unless called for on the plans and/or directed by the Engineer. It is the Contractor's responsibility to detect and protect existing utilities (to remain) from damage during construction. The Contractor shall locate buried utilities, to the best of his ability, using electronic probes, or other methods, prior to the start of excavation. The Contractor shall then proceed cautiously and perform hand excavation, as necessary, to protect the utility as directed by the Engineer, at no extra cost to the Owner. If a utility is inadvertently damaged, it is the Contractor's responsibility to restore that utility to operating condition, equal to that existing prior to damage. The Contractor shall remain at the site with the damaged utility until it has been restored and there is no danger to the public (i.e. exposed live electrical wires, etc.).

Should the Contractor need to cut off utilities or services during the performance of the work, he shall notify the appropriate Utility Company owning or controlling services, to cut off these services. It is the Contractor's responsibility to provide sufficient advance notice to the Utility Company so that work not is delayed. The cost of any such delay in work shall be solely borne by the Contractor.

Any services cut off or interrupted by the Contractor's operations shall be restored at the Contractor's expense.

3.4 DE-WATERING

- A. Provide all required channeling, piping, and pumping necessary to keep excavated areas clear of standing water. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area. Maintain site drainage at all times.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  - 2. Install a de-watering system to keep subgrades dry and convey ground water away from excavations. Maintain until de-watering is no longer required.
- C. Dispose with outfall to existing storm water systems. Prevent erosion or siltation of existing drainage systems by use of filter socks and other approved materials.
- D. At completion of de-watering activities, remove temporary facilities and restore any damaged areas.

3.5 FILL

- A. Remove all vegetation, topsoil, debris, wet and unsuitable materials, obstructions, and deleterious materials from the ground surface prior to placing fills. Unsuitable subgrade material as determined by the Engineer may be removed in accordance with Section 3.3 D of this Specification.
- B. Fill and Compacting shall be carried out as directed by the Engineer, and shall be constructed in successive horizontal layers not over 6 inches in depth. It shall be spread by a "Bulldozer", or other acceptable methods, and shall be thoroughly compacted by rolling with a self-propelling roller weighing not less than ten (10) tons and completed to the satisfaction of the Engineer. In places where the character of the material makes the use of this roller impracticable or where drains or other construction may be damaged a lighter one may be substituted, or the area shall be compacted by vibratory tamping, all with the approval, and to the satisfaction of the Engineer.
- C. All hollows and depressions which develop during the process of rolling and compacting shall be filled with suitable material, and the subgrade shall again be compacted. This process of filling and compacting shall be repeated until no depressions develop.
- D. Plow, strip or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
- E. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and re-compact to required density.

**3.6 BACKFILL**

- A. After inspection and approval of foundations and other work, which is to be covered by backfill, the excavated voids shall be filled with clean excavated material, puddled and rammed solid every 6" of depth.
- B. After areas and trenches have been excavated and structures constructed therein, the spaces around and above them shall be carefully backfilled with suitable material. Backfill shall be placed on both sides of structures to approximately the same elevation at the same time. All backfill shall be thoroughly tamped and rammed in place in layers not over six (6) inches in depth, using rammers of a weight acceptable to the Engineer. If directed by the Engineer, the backfill shall be thoroughly saturated with water as it is placed.
- C. Backfill adjacent to foundation walls shall be pneumatically compacted.
- E. Backfilling around masonry manholes and catch basins shall not take place until the mortar has hardened and the possibility of movement is slight. Backfilling shall take place uniformly around all sides of the structures.
- F. When sheeting is being withdrawn, all cavities left thereby shall be filled with suitable material, tamped in place so as to fill all voids thoroughly. Backfill inside of sheeting shall be placed before sheeting is removed. When approved by the Engineer, sheeting may be cut-off and left in place to avoid settlement caused by extraction. The Contractor is responsible for any settlement that occurs to existing or new structures caused by sheeting removal operations.

**3.7 SAW CUTTING**

- A. Saw cutting shall be done by competent workers in an approved manner to the satisfaction of the Engineer.
- B. All saw cutting shall be carried out to the full depth of the pavement, curb or concrete walk to be cut. Saw cutting shall be done to accurate, neat and straight lines marked previous to commencement of work. Saw cutting shall be done with approved power saws specifically designed and manufactured for such a purpose. Compressor, backhoe or spade-cutting of the pavement will not be allowed.
- C. Workmen shall wear safety clothing and eye protection while operating saw equipment and shall be thoroughly familiar in the safe operation of the equipment.

**END OF SECTION**

SECTION 31 23 23 - BORROW SOIL FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Providing borrow soil fill for lawns and athletic fields. Borrow soil fill may be excavation material produced from the building excavation as long as it meets the specification herein or is modified to meet the specification herein.
  - 2. The work of this section does not include borrow topsoil. This is provided under a separate specification section.

1.3 RELATED SECTIONS

- A. Section 31 23 16 - Earthwork
- B. Section 31 23 17 - Unclassified Excavation

1.4 DEFINITIONS

- A. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- B. Fill: Soil materials used to raise existing grades.

1.5 QUALITY ASSURANCE

- A. Borrow Soil Fill:
  - 1. Testing: Representative samples of borrow soil fill shall be completely analyzed/ tested to determine:
    - a. Nutrient analysis using the Modified Morgan extractant for soil available P, K, Ca, and Mg.
    - b. Soil pH.



- c. Organic content- determined by loss of weight on ignition.
  - d. Particle size analysis - sand, silt, and clay - analysis shall be determined using the hydrometer or pipette methods of particle size analysis with size fractions based upon size limits established by USDA.
2. Before delivery of any borrow soil fill, furnish the Architect with a 5 gallon sample of material.
  3. Borrow soil fill testing costs shall be borne by the Contractor.
  4. Testing laboratory shall be:

Soils Testing Laboratory  
Horticulture Storage Building  
University of Connecticut  
2019 Hillside Road  
Storrs, CT 06269

Substitute laboratory may be used only if approved by the Owner and Architect.

#### 1.6 SUBMITTALS

- A. Submit borrow soil fill test results for approval.
- B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
  1. Classification according to ASTM D 2487 of each borrow soil material proposed for fill. Soil test verifying borrow soil composition and percentages of silt, sand, clay and organic matter.
  2. Laboratory compaction curve according to ASTM D 698 for each borrow soil material proposed for fill and backfill.
  3. Laboratory compaction curve according to ASTM D 1557 for each borrow soil material proposed for fill.
- C. Modified Building Excavation Material: Excavated material must be tested before modification to determine the amounts and types of material to be added to comply with the specifications herein. Modified material must then be thoroughly mixed and then tested for compliance with requirements indicated above in Items 1.5.A and 1.5.B.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from on site earthwork.
- B. Borrow Soil Fill material shall be soil material classified as a sandy loam soil that contains:
  - 7 to 20 percent clay
  - more than 52 percent sand
  - and the percentage of silt plus (2 times the percent clay) = 30 percent or greater

**or**

  - less than 7 percent clay
  - less than 50 percent silt
  - more than 43 percent sand

PART 3 - EXECUTION

3.1 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Do not store within drip line of remaining trees.

3.2 INSTALLATION AND ROUGH GRADING

- A. Conform to Section 31 23 16 - Earthwork.

**END OF SECTION**

SECTION 31 23 33 - TRENCHING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Trenching, sheeting and dewatering as specified herein, and as needed for installation of sanitary sewer, storm drainage, other utilities, and appurtenances associated with the Work.

1.3 RELATED WORK DESCRIBED ELSEWHERE

- A. Section 31 23 16 - Earthwork
- B. Section 31 23 17 - Unclassified Excavation
- C. Section 33 10 00 - Water Distribution
- D. Section 33 30 00 - Sanitary Sewer
- E. Section 33 40 00 - Storm Drainage

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this Section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.
- C. Comply with requirements and regulations of utility companies and governmental agencies having jurisdiction.
- D. Refer to Section 31 23 16 - Earthwork for compaction requirements.

1.5 PROJECT CONDITIONS

- A. Contact Call Before You Dig services for Connecticut (1.800.922.4455) to locate underground utilities prior to commencing site preparation operations a minimum of 2 days before beginning any work at the site.
- B. West Nile Virus Precautions: To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. As selected by the Contractor.

PART 3 EXECUTION

3.1 PROJECT CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed with the work of this section until unsatisfactory conditions are corrected.
- B. Finish Elevations and Lines:
  - 1. Locate and protect control points during progress of the Work.
  - 2. Preserve permanent reference points during progress of the Work.
  - 3. Do not change or relocate reference points or items of the Work without written approval from the Engineer.

3.2 EXECUTION

- A. Utilities:
  - 1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.

2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted. Inform Engineer of existing utility line before proceeding.
  3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
  4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineer for review and written direction before proceeding with modifications to the work. Do not proceed with permanent relocation of utilities until written direction is received from the Engineer.
- B. Protection of Persons and Property:
1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access to the work.
  2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
  3. Protect existing structures, utilities, sidewalks, pavements, fences and other facilities from damage caused by trenching, settlement, lateral movement, washout, and other hazards created by operations under this Section. All existing features affected and/or damaged by the work of this Section shall be brought back to their original conditions at no cost to the Owner.
- C. Dewatering:
1. Remove all water, including rain water, encountered during trench and substructure work to an approved location by pumps, drains, and other approved methods.
  2. Keep excavations and site construction free from water.
  3. To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.
- D. Dust Prevention:
1. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site in conformance with Form 816, Article 9.42.01 - 9.42.03 or Form 816, Article 9.43.01 - 9.43.03.
- E. Maintain access to the site at all times.

3.3 TRENCHING PROCEDURES

A. Trench Excavation:

1. Trench excavation shall be as described in Form 816, Article 2.05.01, under the "Trench Excavation" classifications presented therein.
2. Construction methods shall conform to Articles 2.05.03 and 10.01.03 of Form 816, where applicable.
3. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit.
4. Clearance: 12 inches minimum each side of pipe or conduit.
5. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.
6. Place and compact bedding material on rock or other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Rock in Trench Excavation:

1. Excavation of trench shall be as described in Form 816, Article 2.05.1, under the "Rock in Trench" classification presented therein.
2. Construction methods shall conform to Article 2.05.03 of Form 816, where applicable.

C. Comply with pertinent provisions of Section 31 23 16 - Earthwork.

D. Provide sheeting and shoring as necessary for protection of the Work and for the safety of personnel. Conform to Form 816, Article 7.14.01 - 7.14.03.

1. Prior to backfilling, remove all sheeting.
2. Do not permit sheeting to remain in the trenches except when field conditions or the type of sheeting or methods or construction such as the use of concrete bedding are such as to make removal of sheeting impracticable. In such cases, portions of sheetings may be cut off and remain in the trench as approved by the Owner.

E. Miscellaneous:

1. Short sections of a trench may be tunneled, subject to approval of the Engineer, if the conductor conduit and backfill can be installed and compacted properly into such tunnel.

2. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill and compact the voids remaining after removal of the objects in accordance with Section 31 23 16 at no additional cost to the Owner.
    - a. If a void is below the subgrade for the utility bedding, use suitable earth materials and compact to a relative density of no less than 95%.
    - b. If a void is in the side of the utility trench of open cut, use suitable earth or sand compacted or consolidated to a relative density of no less than 90%.
  3. Excavating for appurtenances:
    - a. Excavate for dry wells, hydrants and similar structures to a distance sufficient to leave at least 12" clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
    - b. Overdepth excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as approved by the Engineer, and at no additional cost to the Owner.
  4. Trench to the minimum width necessary for property installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for the utility.
  5. Depressions:
    - a. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
    - b. Except where rock is encountered, do not excavate below the depth indicated or specified.
    - c. Where rock is encountered, excavate rock to a minimum overdepth of 4" below the trench depth indicated or specified.
- F. Where utility trenching, piping and/or conduit traverses public property and/or is subject to governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements and/or regulations as set forth by authority having jurisdiction, but in no case shall the depth be less than that shown in the Contract Documents.
- G. Cover:
1. Provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade or subgrade:
    - a. Storm drains: 18"
    - b. Sewer pipes: 36"

- c. Raceways: 30"
  - d. Water pipes: 48"
- 
- 2. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.
  - 3. Where the minimum cover is not provided, encase the pipes in concrete as indicated on the Drawings. Provide concrete with a minimum 28 day compressive strength of 3000 psi with entrained air 5 to 7 percent. Mechanically consolidate concrete.

3.4 BACKFILLING AND COMPACTION

- A. Excavations shall be backfilled and compacted in accordance with Section 31 23 16.

**END OF SECTION**



SECTION 31 25 00 - SEDIMENT AND EROSION CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Connecticut Guidelines for Soil Erosion and Sediment Control", Connecticut Council on Soil and Water Conservation, May 2002, inclusive of all supplements and/or its latest revision or edition.
- C. Form 816 shall mean State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816 – 2004 or its latest edition and any supplemental specifications.

1.2 SECTION INCLUDES

- A. Hay bales, filter fabric fence, sediment barriers and sedimentation structures
- B. Temporary mulch
- C. Temporary sediment basins as required by field conditions

1.3 QUALITY ASSURANCE

- A. All erosion and sediment control measures will be constructed in accordance with the standards and specifications of the "Connecticut Guidelines for Soil Erosion and Sediment Control".

1.4 PROJECT CONDITIONS

- A. Land disturbance will be kept to a minimum; re-stabilization will be scheduled as soon as possible. Temporary seeding or permanent hydro-seeding should take place immediately upon completion of grading. Permanent seeding will be scheduled during March 15 - June 15; August 15 - October 15.
- B. Erosion and sediment control measures will be installed prior to construction whenever possible and will be maintained in effective condition throughout the construction period.
- C. Hay bale filters will be installed at the base of all proposed slopes and on the downhill side of any area receiving new planting and as instructed by the Engineer.

- D. Additional control measures will be installed during the construction period as required by field conditions or as requested by the Engineer.
- E. Sediment removed from control structures will be disposed of on site in a manner approved by the Engineer.
- F. Mulch all new slopes 3% or greater. Use straw or hay (70-90 lbs. 1,000 sq. ft.), free of weeds or coarse matter. Chemical binder such as Petroset Terratack Hydro Mulch and Aerospray will be used as recommended by manufacturer to anchor mulch. Mulch must be inspected periodically, in particular, after rainstorms to check for rill erosion. Where erosion is severe, repair the eroded area and place additional mulch as required to control the erosion. Grasses shall not be considered established until a ground cover is achieved, which is mature enough to control soil erosion and to survive severe weather conditions.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### A. Hay Bales:

- 1. Hay bales shall be made of hay with 40 lbs. minimum weight, and 120 lbs. maximum weight. The hay bales shall be sufficiently bound with either wire or nylon twine to resist breaking apart during their use, shipment or placement.
- 2. Stakes shall be wood, minimum two inches (2") by two inches (2") by three feet (3') long.

#### B. Filter Fabric:

- 1. Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene filaments and shall be certified by the manufacturer or supplier as conforming to the following requirements:

Minimum Filtering Efficiency:	75%
Minimum Tensile Strength at 20% Elongation for Extra Strength:	50 lbs./lin. in.
for Regular Strength:	30 lbs./lin. in.
Minimum Flow Rate:	0.3 gal./min./sq.ft.

- C. Temporary mulch: clean oat straw, wheat straw, timothy hay, a mixture of clover and timothy hay or other approved native or forage grasses; well-seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.
- D. Crushed stone: crushed or broken stone conforming to the requirements of Section M.02.01-1 "Broken or Crushed Stone" of ConnDOT Form 816. Gradation shall conform to No. 8 (1/4" stone) per Section M.01.01.

**PART 3 EXECUTION**

**3.1 PREPARATION**

- A. Conduct construction operations in compliance with all terms of regulation agency requirements, including requirements noted on the Contract Drawings.
- B. Retain all sediments within the contract limits, and within designated disposal areas.
- C. Install erosion control measures prior to beginning site disturbance. Maintain erosion control measures throughout construction period, install additional measures if necessary to retain all sediment on site. Install any additional erosion control measures which may be required by local regulatory officials.

**3.2 SEDIMENT BARRIERS**

- A. Sediment barriers shall be limited to hay bales for sheet flow applications installed in accordance with Item 1.1.B.
- B. Hay Bales:
  - 1. Bales shall be placed in a single row, with ends of adjacent bales tightly abutting one another. Bales shall be oriented lengthwise on the contour for sheet flow applications, perpendicular to the contour for channel flow applications, and in a square or rectangular shape around depressed catch basin inlets.
  - 2. Bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent deterioration of the bindings.
  - 3. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of the bale and the length of the proposed barrier to a minimum depth of four inches (4"). After the bales are staked and chinked, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to four inches (4") against the uphill side of the barrier.
  - 4. For channel flow applications, the barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale to assure that sediment laden runoff will flow either through or over the barrier but not around it.
  - 5. The areas immediately around catch basins may be excavated slightly to increase ponding of runoff water around catch basins.

6. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes shall be driven deep enough into the ground to securely anchor the bales.
7. The gaps between bales shall be chinked with straw to prevent water from escaping between bales.
8. In sloping areas where surface flow follows the bale line, perpendicular bale checks shall be installed at appropriate intervals (100 feet maximum).

C. Filter Fabric

1. Filter fabric, when used, shall be wrapped around all existing and proposed trench drain and catch basin and inlet grates to prevent sediment from entering the storm drainage system. The fabric shall be wrapped tightly around the outside of the grate structure and the grate placed securely back inside the receiving frame.
2. Where soil stockpiles are to be placed directly over trench drains or inlets, the fabric shall be wrapped a minimum of two (2) times around the grate structure.

3.3 TEMPORARY MULCH

- A. Place mulch uniformly in a continuous blanket at a rate of 2 ½ tons per acre, or two 50 pound bales per 1,000 square feet of area. A mechanical blower may be used for mulch application. Do not spread/apply mulch by mechanical means or by hand on windy or gusty days.
- B. Crimp straw into soil by mechanical means.
- C. On all slopes 4:1 or steeper, anchor mulch with liquid tackifier applied uniformly at a rate of 60 gallons per acre.
- D. Protect buildings, paving, planting and all non-seeded areas from liquid tackifier overspray.

3.4 INSPECTION AND MAINTENANCE

- A. General
  1. Inspection shall be frequent, and shall be made after each storm event. Repair or replacement shall be made promptly as needed.
- B. Hay Bales
  1. Cleanout of accumulated sediment behind the bales is necessary if ½ of the original height of the bales becomes filled with sediment.

2. Hay bales shall be replaced after their expected useful life of 60 days.
3. Bale barriers shall be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized and the completion of construction activities.

C. Filter Fabric Fence

1. Fabric placed around grates shall be replaced whenever the fabric becomes torn, stretched or otherwise damaged so that it can no longer perform its function.

D. Sedimentation Basins

1. Temporary sedimentation basins shall be cleaned-out once one-half of the basin volume becomes filled with sediment.

**END OF SECTION**

SECTION 31 66 13 - HELICAL PILES

Part 1 GENERAL

1.01 Purpose of Specification

The purpose of this specification is to detail the furnishing of all designs, materials, tools, equipment, labor and supervision, and installation and load testing techniques necessary to install Helical Piles at locations shown on the Drawings, including connection details.

1.02 Scope of Work

This work consists of furnishing all necessary engineering and design services, supervision, labor, tools, materials, and equipment to perform all work necessary to install and load test the Helical Piles, per the specifications described herein, and as shown on the Drawings. The Contractor shall install a Helical Pile that will develop the load capacities as detailed on the Drawings. This includes load testing to verify Helical Pile capacity and deflection.

1.03 Qualifications of the Helical Pile Contractor

The Helical Pile Contractor shall be experienced in performing design and construction of Helical Piles and shall furnish all materials, labor, and supervision to perform the work. The Helical Pile Contractor shall not sublet the whole or any part of the contract without the express written permission of the Owner.

1.04 Related Project Specifications

1. Section 31 20 00 – Building Earthwork

1.05 Definitions

1. **Coupling:** Central steel shaft connection means formed as integral part of the plain extension shaft material. For Type SS & RS Helical Piles, couplings are internal or external sleeves, or hot upset forged sockets.
2. **Coupling Bolt(s):** High strength, structural steel fasteners used to connect Helical Pile segments together. For Type SS segments, the coupling bolt transfers axial load. For Type RS segments, the coupling bolts transfer both axial and torsional forces.
3. **Helical Extension:** Helical Pile foundation component installed immediately following the lead or starter section, if required. This component consists of one or more helical plates welded to a central steel shaft of finite length. Function is to increase bearing area.

4. Helix Plate: Generally round steel plate formed into a ramped spiral. The helical shape provides the means to install the helical pile, plus the plate transfers load to soil in end bearing. Helix plates are available in various diameters and thickness.
  5. Helical Pulldown Micropile (HPM): A small diameter, soil displacement, cast-in-place Helical Pile, in which most of the applied load is resisted by the central steel shaft and steel reinforcement, if installed. Load transfer to soil is both end bearing and friction.
  6. Helical Pile: A bearing type foundation element consisting of a lead or starter section, helical extension (if so required by site conditions), plain extension section(s), and a pile cap.
  7. Installation Torque(T): The resistance generated by a Helical Pile when installed into soil. The installation resistance is a function of the soil type, and size and shape of the various components of the Helical Pile.
  8. Lead Section: The first Helical Pile foundation component installed into the soil, consisting of single or multiple helix plates welded to a central steel shaft.
  9. Pile Cap: Connection means by which structural loads are transferred to the Helical Pile.
  10. Round Shaft (RS): **R**ound steel pipe central **S**haft elements ranging in diameter from 2-7/8" to 10".
  11. Plain Extension: Central steel shaft segment without helix plates. It is installed following the installation of the lead section or helical extension (if used). The segments are connected with integral couplings and bolts. Plain extensions are used to extend the helix plates beyond the specified minimum depth and into competent load bearing stratum.
  12. Safety Factor: The ratio of the ultimate capacity to the working or design load used for the design of any structural element.
  13. Square Shaft (SS): Solid steel, round-cornered-**S**quare central **S**haft elements ranging in size from 1-1/4" to 2-1/4".
  14. Torque Strength Rating: The maximum torque energy that can be applied to the helical pile foundation during installation in soil, a.k.a. allowable, or safe torque.
- 1.06 Allowable Tolerances
1. Centerline of Helical Piles shall not be more than 3 inches from indicated plan location.
  2. Helical Pile plumbness shall be within 2° of design alignment.
  3. Top elevation of Helical Pile shall be within +1 inch to -2 inches of the design vertical elevation.

1.07 Quality Assurance

1. The Contractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the work of this specification.
2. All Helical Piles shall be installed in the presence of the Owner's Geotechnical Engineer, who shall have the right of access to all field installation records and test reports.
3. Helical Pile components as specified therein shall be manufactured by a facility whose quality systems comply with ISO (International Organization of Standards) 9001 requirements. Certificates of Registration denoting ISO Standards Number shall be presented upon request to the Owner or their representative.
4. Design of Helical Piles shall be performed by a licensed professional engineer registered in the State of Connecticut.

1.08 Design Criteria

1. Helical Piles shall be designed to meet the specified loads and acceptance criteria as shown on the Drawings. The calculations and drawings required from the Contractor or Engineer shall be submitted to the Owner for review and acceptance in accordance to Section 3.1 Submittals.
2. The allowable working load on the Helical Piles shall not exceed the following values:

- a. For compression loads:

$$P_{allowc} = 0.4 * f_{yshaft} * A_{shaft}$$

Where:  $P_{allowc}$  = allowable working load in compression (kip)  
 $f_{yshaft}$  = minimum yield strength of central steel shaft (ksi)  
 $A_{shaft}$  = area of central steel shaft (the Contractor's Helical Pile design engineer shall assume 1/16 in. sacrificial steel from all steel surfaces as a corrosion allowance) (in.<sup>2</sup>)

3. The ultimate structural capacity shall be determined as:

- a. For compression loads:

$$P_{ultc} = f_{yshaft} * A_{shaft}$$

Where:  $P_{ultc}$  = ultimate structural capacity in compression (kip)  
 $f_{yshaft}$  = minimum yield strength of central steel shaft (ksi)  
 $A_{shaft}$  = area of central steel shaft (the Contractor's Helical Pile design engineer shall assume 1/16 in. sacrificial steel from all steel surfaces as a corrosion allowance) (in.<sup>2</sup>)



4. Helical Pile capacity in soil shall not be relied upon from the following soil layers as defined in the geotechnical reports: fill and, if present, organics, and other unsuitable soils.

The overall length and installed torque of a Helical Pile shall be specified such that the required in-soil capacity is developed by end-bearing on the helix plates in the natural undisturbed sand below the fill and other unsuitable soils.

5. The Helical Pile attachment (pile cap) shall distribute the design load (DL) to the concrete foundation such that the concrete bearing stress does not exceed those in the ACI Building Code and the stresses in the steel plates/welds do not exceed AISC allowable stresses for steel members.

#### 1.09 Ground Conditions

1. Examine the site, records of existing utilities and construction, record of test borings, subsurface exploration reports, and the soil samples and rock cores to determine conditions under which the work will be performed. Subsurface information is contained in the 29 June 2006 report entitled "Geotechnical Engineering Report, Eli Whitney CTHSS, Hamden, Connecticut" and in a letter dated 10 March 2008, both by Haley & Aldrich, Inc. The soil samples are available for review at the offices of Haley & Aldrich, Inc., 100 Corporate Place, Suite 105, Rocky Hill, Connecticut 06067-1803, Phone: 860-282-9400. The report and letter are made available for information on factual data only and shall not be interpreted as a warranty of subsurface conditions whether interpreted from written text, test boring logs or other data. The test boring and test pit information represents subsurface conditions at the exploration locations at the time conducted.

### Part 2 REFERENCED CODES AND STANDARDS

Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation. In case of conflict, the particular requirements of this specification shall prevail. The latest publication as of the issue of this specification shall govern, unless indicated otherwise.

#### 2.01 American Society for Testing and Materials (ASTM):

1. ASTM A29/A29M Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished.
2. ASTM A36/A36M Structural Steel.
3. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware.
5. ASTM A252 Welded and Seamless Steel Pipe Piles.
6. ASTM A775 Electrostatic Epoxy Coating

7. ASTM A193/A193M Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
  8. ASTM A320/A320M Alloy-Steel Bolting Materials for Low Temperature Service.
  9. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  10. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  11. ASTM A513 Standard Specification for Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing.
  12. ASTM A536 Standard Specifications for Ductile Iron Castings
  13. ASTM A572 HSLA Columbium-Vanadium Steels of Structural Quality.
  14. ASTM A618 Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
  15. ASTM A656 Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability.
  16. ASTM A958 Standard Specification for Steel Castings, Carbon, and Alloy, with Tensile Requirements, Chemical Requirements Similar to Wrought Grades.
  17. ASTM A1018 Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.
  18. ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load.
  19. ASTM D3689 Method of Testing Individual Piles Under Static Axial Tensile Load.
- 2.02 American Welding Society (AWS):
1. AWS D1.1 Structural Welding Code – Steel.
  2. AWS D1.2 Structural Welding Code – Reinforcing Steel.
- 2.03 American Society of Civil Engineers (ASCE):
1. ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations.
- 2.04 Deep Foundations Institute (DFI):
1. Guide to Drafting a Specification for High Capacity Drilled and Grouted Micropiles for Structural Support, 1<sup>st</sup> Edition, Copyright 2001 by the Deep Foundation Institute (DFI).

2.05 Society of Automotive Engineers (SAE):

1. SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners.

### Part 3 SUBMITTALS

3.01 Construction Submittals

1. The Contractor or Engineer shall prepare and submit to the Owner, for review and approval, working drawings and design calculations for the Helical Piles intended for use at least 14 calendar days prior to planned start of construction (but note also Paragraph 3.1.8). All construction submittals shall be signed and sealed by a Registered Professional Engineer licensed in the State of Connecticut that is retained by the Helical Pile Contractor.
2. The Contractor shall submit a detailed description of the construction procedures proposed for use to the Owner for review. This shall include a list of major equipment to be used.
  - a. The Working Drawings shall include the following:
  - b. Helical Pile number, location and pattern by assigned identification number
  - c. Helical Pile design load
  - d. Type and size of central steel shaft
  - e. Helix configuration (number and diameter of helix plates)
  - f. Minimum effective installation torque
  - g. Minimum overall length
  - h. Cut-off elevation
  - i. Helical Pile attachment to structure relative to grade beam, column pad, pile cap, etc.
3. The Contractor shall submit shop drawings for all Helical Pile components, including corrosion protection and pile top attachment to the Owner for review and approval. This includes Helical Pile lead/starter and extension section identification (manufacturer's catalog numbers).
4. The Contractor shall submit certified mill test reports for the central steel shaft, as the material is delivered, to the Owner for record purposes. The ultimate strength, yield strength, % elongation, and chemistry composition shall be provided.
5. The Contractor shall submit plans for load testing of the Helical Piles to the Owner for review and acceptance prior to beginning load tests. The purpose of the test is to determine the load versus displacement response of the Helical Pile and provide an estimation of ultimate capacity.
6. The Contractor shall submit to the Owner copies of calibration reports for each torque indicator or torque motor, and all load test equipment to be used on the project. The calibration tests shall have been performed within forty five (45) working days of the date submitted. Helical Pile installation and testing shall not proceed until the Owner has received the calibration reports. These calibration reports shall include, but are not limited to, the following information:
  - a. Name of project and Contractor
  - b. Name of testing agency
  - c. Identification (serial number) of device calibrated
  - d. Description of calibrated testing equipment

- e. Date of calibration
  - f. Calibration data
7. Work shall not begin until all the submittals have been received and approved by the Owner. The Contractor shall allow the Owner a reasonable time to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.

### 3.02 Installation Records

The Contractor shall provide the Owner copies of Helical Pile installation records within 24 hours after each installation is completed. Records shall be prepared in accordance with the specified division of responsibilities as noted in Table-1. Formal copies shall be submitted on a weekly basis. These installation records shall include, but are not limited to, the below-listed information. All installation record submittals shall be signed and sealed by a Registered Professional Engineer licensed in the State of Connecticut that is retained by the Helical Pile Contractor unless otherwise indicated by the Geotechnical Engineer.

- 1. Name of project and Contractor
- 2. Name of Contractor's supervisor during installation
- 3. Date and time of installation
- 4. Name and model of installation equipment
- 5. Type of torque indicator used
- 6. Location of Helical Pile by assigned identification number
- 7. Actual Helical Pile type and configuration – including lead section (number and size of helix plates), number and type of extension sections (manufacturer's SKU numbers)
- 8. Helical Pile installation duration and observations
- 9. Total length of installed Helical Pile
- 10. Cut-off elevation
- 11. Installation torque at one-foot intervals for the final 10 feet
- 12. Comments pertaining to interruptions, obstructions, or other relevant information
- 13. Rated load capacities

3.03 Test Reports

The Contractor shall provide the Owner copies of field test reports within 24 hours after completion of the load tests. Records shall be prepared in accordance with the specified division of responsibilities as noted in Table-1. Formal copies shall be submitted within a reasonable amount of time following test completion. These test reports shall include, but are not limited to, the below-listed information (note Section 6 – Helical Pile Load Tests). All test report submittals shall be signed and sealed by a Registered Professional Engineer licensed in the State of Connecticut that is retained by the Helical Pile Contractor unless otherwise indicated by the Geotechnical Engineer.

1. Name of project and Contractor
2. Name of Contractor's supervisor during installation
3. Name of third party test agency, if required
4. Date, time, and duration of test
5. Location of Helical Pile by assigned identification number
6. Type of test (i.e. tension or compression)
7. Description of calibrated testing equipment and test set-up
8. Actual Helical Pile type and configuration – including lead section, number and type of extension sections (manufacturer's SKU numbers)
9. Steps and duration of each load increment
10. Cumulative pile-head movement at each load step
11. Comments pertaining to test procedure, equipment adjustments, or other relevant information
12. Signed by Geotechnical Engineer's field representative.

3.04 Closeout Submittals

1. Warranty: Warranty documents specified herein
  - a. Project Warranty: Refer to Conditions of the Contract for project warranty provisions
  - b. Manufacturer's Warranty: Submit, for Owner's Acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights the Owner may have under Contract Document.

Part 4 PRODUCTS AND MATERIALS

- 4.01 Central Steel Shaft: The central steel shaft, consisting of lead sections, helical extensions, and plain extensions, shall be Type SS as manufactured by CHANCE Civil Construction (Centralia and Independence, MO) or approved equal.
1. SS175 1-3/4 Material: Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.
    - a. Torque strength rating: 11,000 ft-lb
    - b. Minimum yield strength = 90 ksi
- 4.02 Helix Bearing Plate: Shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to the following ASTM specifications.
1. SS175 Material: Per ASTM A656 or A1018 with minimum yield strength of 80 ksi. Plate thickness is 3/8" or 1/2".
- 4.03 Bolts: The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications.
1. SS175 1-3/4" Material: 7/8" diameter bolt per ASTM A193 Grade B7.
- 4.04 Couplings: The coupling shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets.
- 4.05 Plates, Shapes, or Pile Caps: The pile cap shall be a welded assembly consisting of structural steel plates and shapes designed to fit the pile and transfer the applied load. Structural steel plates and shapes for Helical Pile top attachments shall conform to ASTM A36 or ASTM A572 Grade 50.
- 4.06 Corrosion Protection
1. Galvanization: All pile material shall be hot-dipped galvanized in accordance with ASTM A153 after fabrication.

Part 5 EXECUTION

5.01 Site Conditions

1. Prior to commencing Helical Pile installation, the Contractor shall inspect the work of all other trades and verify that all said work is completed to the point where Helical Piles may commence without restriction.
2. The Contractor shall verify that all Helical Piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.
3. In the event of a discrepancy, the Contractor shall notify the Owner. The Contractor shall not proceed with Helical Pile installation in areas of discrepancies until said discrepancies have been resolved.

5.02 Installation Equipment

1. Shall be rotary type, hydraulic power driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM's) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.
2. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper Helical Pile alignment.

5.03 Installation Tooling

1. Shall consist of equipment provided by the pile manufacturer and used in accordance with the manufacturer's installation instructions.
2. A torque indicator shall be used during Helical Pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling.
  - a. Shall be capable of providing continuous measurement of applied torque throughout the installation.
  - b. Shall be capable of torque measurements in increments of at least 500 ft-lb
  - c. Shall be calibrated prior to pre-production testing or start of work. Torque indicators which are an integral part of the installation equipment, shall be calibrated on-site. Torque indicators which are mounted in-line with the installation tooling, shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.
  - d. Shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the torque measurements.

5.04 Installation Procedures

1. Central Steel Shaft: (Lead and Extension Sections)

- a. The Helical Pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project.
- b. The lead section shall be positioned at the location as shown on the working drawings. Battered Helical Piles can be positioned perpendicular to the ground to assist in initial advancement into the soil before the required batter angle shall be established. The Helical Pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 20 RPM's. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.
- c. Sufficient down pressure shall be applied to uniformly advance the Helical Pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

5.05 Termination Criteria

1. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
2. The minimum installation torque and minimum overall length criteria as shown on the working drawings shall be satisfied prior to terminating the Helical Pile installation.
3. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:
  - a. Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or:
  - b. Remove the existing Helical Pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.
4. If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:
  - a. Install the Helical Pile deeper using additional extension sections, or:
  - b. Remove the existing Helical Pile and install a new one with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.
  - c. De-rate the load capacity of the Helical Pile and install additional Helical Pile(s). The de-rated capacity and additional Helical Pile location shall be subject to the review and acceptance of the Owner.



5. If the Helical Pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the Helical Pile re-installed. If the obstruction can't be removed, the Helical Pile shall be installed at an adjacent location, subject to review and acceptance of the Owner.
6. If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the Helical Pile to facilitate extension removal.
7. The average torque for the last three feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

## Part 6 LOAD TESTING

### 6.01 Test on Production Pile

One load test shall be performed on the first production pile to verify the capacity and the installation procedures of the proposed Helical Pile, prior to installation of the remaining helical piles. The Owner shall determine the location, acceptable load and movement criteria, and the type(s) of load direction (i.e., tension, compression, or both). Additional purpose of pre-production tests is to empirically verify the ultimate capacity to the average installing torque of the Helical Pile for the project site.

Pre-production Helical Pile installation methods, procedures, equipment, and overall length shall be identical to the production Helical Piles to the extent practical except where approved otherwise by the Owner.

The Contractor shall submit for review and acceptance the proposed Helical Pile load testing procedure. The test shall be in general conformance with ASTM D1143 Quick Load Test procedure and D-3689, and shall provide the minimum following information:

- Type and accuracy of load equipment
- Type and accuracy of load measuring equipment
- Type and accuracy of pile-head deflection equipment
- General description of load reaction system, including description of reaction anchors
- Calibration report for complete load equipment, including hydraulic jack, pump, pressure gauge, hoses, and fittings.

If the test fails to meet the design requirements, the Contractor shall modify the Helical Pile design and/or installation methods and retest the modified anchor.

6.02 Load Test Equipment

1. The load test equipment shall be capable of increasing or decreasing the applied load incrementally. The incremental control shall allow for small adjustments, which may be necessary to maintain the applied load for a sustained, hold period.
2. The reaction system shall be designed so as to have sufficient strength and capacity to distribute the test loads to the ground. It should also be designed to minimize its movement under load and to prevent applying an eccentric load to the pile head. Test loads are normally higher than the design loads on the structure. The direction of the applied load shall be collinear with the Helical Pile at all times.
3. Dial gauge(s) shall be used to measure Helical Pile movement. The dial gauge shall have an accuracy of at least  $\pm 0.001$ -in. and a minimum travel sufficient to measure all Helical Pile movements without requiring resetting the gauge. The dial gauge shall be positioned so its stem is parallel with the axis of the Helical Pile. The stem may rest on a smooth plate located at the pile head. Said plate shall be positioned perpendicular to the axis of the Helical Pile. The dial gauge shall be supported by a reference apparatus to provide an independent fixed reference point. Said reference apparatus shall be independent of the reaction system and shall not be affected by any movement of the reaction system.
4. The load test equipment shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the load or deflection measurements.

6.03 Testing Program

1. The hydraulic jack shall be positioned at the beginning of the test such that the unloading and repositioning of the jack during the test shall not be required. The jack shall also be positioned co-axial with respect to the pile-head so as to minimize eccentric loading. The hydraulic jack shall be capable of applying a load not less than two times the proposed design load (DL). The pressure gauge shall be graduated in 100 psi increments or less. The stroke of the jack shall not be less than the theoretical elastic shortening of the total Helical Pile length at the maximum test load.
2. An alignment load (AL) shall be applied to the Helical Pile prior to setting the deflection measuring equipment to zero or a reference position. The AL shall be no more than 10% of the design load (i.e., 0.1 DL). After AL is applied, the test set-up shall be inspected carefully to ensure it is safe to proceed.
3. Axial compression load test shall be conducted by loading the Helical Pile in step-wise fashion as shown in the table to the extent practical. Pile-head deflection shall be recorded at the beginning of each step and after the end of the hold time. The beginning of the hold time shall be defined as the moment when the load equipment achieves the required load step.
4. Test loads shall be applied until continuous jacking is required to maintain the load step or until the test load increment equals 200% of the design load (DL) (i.e., 2.0 DL), whichever occurs first. The observation period for this last load increment shall be 10 minutes. Displacement readings shall be recorded at 1, 2, 3, 4, 5 and 10 minutes (load increment maxima only).

5. The applied test load shall be removed in four approximately equal decrements per the schedule in Table I. The hold time for these load decrements shall be 1 minute, except for the last decrement, which shall be held for 5 minutes.

**Table I.** Steps for Load Testing

LOAD STEP	HOLD TIME (MINUTES)
AL	1.0 Min.
0.20 DL	2.5 Min.
0.40 DL	2.5 Min.
0.60 DL	2.5 Min.
0.80 DL	2.5 Min.
1.0DL	2.5 Min.
0.75 DL	1.0 Min.
0.50 DL	1.0 Min.
0.25 DL	1.0 Min.
AL	1.0 Min.
0.5 DL	1.0 Min.
1.0 DL	1.0 Min.
1.2 DL	2.5 Min.
1.4 DL	2.5 Min.
1.6 DL	2.5 Min.
1.8 DL	2.5 Min.
2.0 DL	10.0 Min.
1.5 DL	1.0 Min.
1.0 DL	1.0 Min.
0.5 DL	1.0 Min.
AL	5.0 Min.

AL = Alignment Load; DL = Design Load

6.04 Acceptance Criteria for HELICAL PILE Verification Load Test

Both of the following criteria must be met for approval:

1. The Helical Pile shall sustain the compression design capacities (1.0 DL) with no more than 0.5 in. net vertical movement of the pile-head after unloading as measured relative to the top of the Helical Pile prior to the start of testing.
2. Failure does not occur at the 2.0 DL maximum compression test load. The failure load shall be defined by one of the following definitions – whichever results in the lesser load:
  - a. The point at which the movement of the Helical Pile tip exceeds the elastic compression of the pile shaft by 0.08 B, where B is defined as the diameter of the largest helix.
  - b. The point at which the slope of the load versus deflection (at end of increment) curve exceeds 0.05 inches/kip.

The Contractor shall provide the Owner copies of field test reports confirming Helical Pile configuration and construction details within 24 hours after completion of the load tests. Formal copies shall be submitted as per Section 3.3. This written documentation will either confirm the load capacity as required on the working drawings or propose changes based upon the results of the pre-production tests.

When a Helical Pile fails to meet the acceptance criteria, modifications shall be made to the design, the construction procedures, or both. These modifications include, but are not limited to, de-rating the Helical Pile load capacity, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the Helical Pile material (i.e., central steel shaft). Modifications that require changes to the structure shall have prior review and acceptance of the Owner. The cause for any modifications of design or construction procedures shall be decided in order to determine any additional cost implications.

## Part 7 MEASUREMENT AND PAYMENT

### 7.01 Measurement

1. Helical piles shall be measured for payment on the basis of length along the axis of the pile in-place below the design cut-off elevation.

### 7.02 Basis of Payment

1. Work included under this contract shall include the total price for installation of the estimated linear feet of helical piles. The work shall include furnishing and installing the piles and all work incidental thereto (including load testing, submittals, etc.), mobilization, and demobilization.
2. Helical pile installation shall include the total price for installation of the number of piles indicated on the Drawings at an assumed 20 ft per pile for initial pricing, and associated load testing in accordance with the requirements herein.
3. Final payment shall be based upon the actual total aggregate footage of helical piles installed and accepted in accordance with this section. If the total aggregate footage is over or under the base quantity, the additional footage shall be paid to the Contractor or the deducted footage shall be credited to the Owner on the basis of the unit prices quoted in the Bid Form. The "Add" unit price shall not be more than 20 percent greater than the unit price determined by dividing the base bid by the base footage. The "Deduct" unit price shall be at least 80 percent of the unit price determined by dividing the base bid by the base footage.
4. The total aggregate footage of helical piles for payment shall be the sum of the lengths of piles below design cut-off grade actually installed, and accepted, whether or not the number of piles is more, equal to, or less than is shown on the Contract Drawings.

5. Helical piles rejected in accordance with the provisions of these Specifications will not be paid for. In such cases, the Contractor will be paid at the contract unit price per foot for one replacement pile installed and accepted according to the provisions of these Specifications. If more than one replacement pile is required to compensate for a rejected pile, the Contractor will be paid at the contract unit price per foot for only the longer of the replacement piles. Additional piles required to compensate for production piles or replacement piles installed out of design location will be installed at no additional cost to the Owner.

**END OF SECTION**

SECTION 32 11 23 - PROCESSED AGGREGATE BASE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide and install a processed stone aggregate base in two courses on a prepared subgrade as shown on the Drawings or as ordered by the Engineer, and as specified herein.

1.3 RELATED WORK

- A. Section 31 23 16 - Earthwork
- B. Section 31 22 13 - Formation of Subgrade
- C. Section 33 46 23.16 - Broken Stone

1.4 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All re-testing in unsatisfactory areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.

1.5 SUBMITTALS

- A. Submit certified test reports and materials certificates, for products specified in this Section, indicating compliance of all proposed materials with specified requirements.

1.6 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work in conformance with Form 816.

PART 2 - PRODUCTS

2.1 PROCESSED STONE AGGREGATE

- A. Conform to Article M.05.01, Form 816.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

- A. Prior to placing the bottom course of processed stone aggregate base, the prepared subgrade shall be maintained true to line and grade, at all times. No placement of the processed aggregate is to commence until acceptance by the Engineer of the subgrade on which it is to be placed.
- B. The formation and protection of subgrade shall conform to the requirements of Section 31 22 13.

3.2 MATERIAL PLACEMENT/COMPACTION

- A. Install processed aggregate base material at the locations as shown on the Drawings and in accordance with Article 3.04.03 of Form 816. Dimensions specified are after compaction.
- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).

**END OF SECTION**

SECTION 32 12 00 - BITUMINOUS CONCRETE PAVEMENT AND MARKINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Form 816" shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 SUMMARY

- A. This Section includes the materials, labor, installation and incidental costs for the installation of subbase material, base materials, bituminous concrete pavement and markings for parking areas, roadways and tennis courts.
- B. Coordinate the work of this Section with Section 32 12 13 - Portland Cement Concrete Pavement and Curbing and Section 32 18 23 - Color Seal Coat System and Court Lines

1.3 RELATED SECTIONS

- A. Section 32 12 13 - Portland Cement Concrete Pavement and Curbing
- B. Section 32 18 23 - Color Seal Coat System and Court Lines

1.4 SUBMITTALS

- A. Material Certificates: Provide material certificates signed by the material producer and the Contractor, certifying that materials and products comply with specified requirements.

1.5 QUALITY ASSURANCE

- A. Material and Methods of Construction: Shall comply with the following standards:
  - 1. American Society for Testing and Materials (ASTM).
  - 2. American Association of State Highway and Transportation Officials (AASHTO).
  - 3. Asphalt Institute (AI).



4. State of Connecticut DOT Standard Specifications, Form 816, inclusive of all supplements.
  5. Federal Highway Administration Manual on Uniform Traffic Control Devices.
  6. State of Connecticut General Statutes.
- B. Testing: Compaction tests may be required by the Owner and shall be paid for by the Contractor. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All retesting in these areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests if required by the Owner and to allow adequate time for the proper execution of said tests.
- D. Allowable Tolerances: Final surface of base materials within 3/8" from a required grade. Final pavement thicknesses shall conform to specified requirements as shown in the Drawings. Test for smoothness using a ten (10) foot long straightedge. Surface shall not vary more than 1/4" from straightedge when placed in any direction. In no case will water be allowed to stand or puddle on any finished pavement.
- E. Permits/Approvals: The Contractor shall obtain approval of construction and secure all permits for all work.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Transporting shipments of bituminous concrete material shall be made in tight vehicles previously cleaned of all foreign material, and delivered to the site, so that it will not become contaminated in any way.

#### 1.7 PROJECT CONDITIONS

A. Weather Limitations

1. Base material shall not be placed on frozen or saturated subbase material.
2. Bituminous concrete paving material shall not be placed on frozen or saturated base material.
3. Cold weather: Bituminous concrete paving materials shall be mixed and placed in accordance with minimum placement temperature as specified in Article 4.06.03, Item 8 - Placing of Mixture, Form 816.
4. Precipitation or Moisture: Placement of bituminous concrete paving materials shall not be scheduled when weather conditions of fog or rain prevail nor when the pavement surface shows signs of any moisture.

5. Precipitation Probability: Placement of bituminous concrete paving materials shall not be scheduled when the Precipitation Probability, obtained by the Contractor from the U.S. Weather Bureau Within three (3) hours prior to the start of such operations, equals or exceeds fifty (50) percent. The Contractor shall notify the Engineer of the exact time at which the above information was obtained.
  
- B. Grade Control: Establish and maintain the required lines and grades for each course during paving operations.
  
- C. Provide temporary barricades and warning lights as required for protection of project work and public safety.
  
- D. Protect adjacent work from damage, soiling and staining during paving operations.
  
- E. Inspection Costs: All costs associated with material certifications, plant inspection and laboratory tests shall be borne by the Contractor and shall be deemed included in the price bid for asphalt pavement.

## PART 2 PRODUCTS

### 2.1 BITUMINOUS CONCRETE PAVEMENT

- A. Conform to the requirements of Article M.04.01, Form 816, Class 2.

### 2.2 TACK COAT

- A. Conform to the requirements of Article M.04.01, Item 1(d), Sub-item (4), Form 816. Tack Coat shall be Grade CSS-1H cationic emulsified asphalt, diluted with water at a 1:1 ratio.

### 2.3 PROCESSED STONE AGGREGATE

- A. Conform to the requirements of Article M.05.01, Form 816.

### 2.4 PAINT

- A. Parking Areas and Roadways - Paint shall be hot-applied, fast drying type in accordance with Form 816, Section M.07.21.
  
- B. Tennis Courts - Conform to specification Section 32 18 23 - Color Seal Coat System and Court Lines.

2.5 WHEEL STOP

- A. Precast concrete wheelstop commercially produced for the intended purpose; consisting of 5,000 psi reinforced concrete with 5-7% entrained air. Length: 6'-0". Approximately 10" wide x 6" high, with a 45-degree bevel on the front face. Furnished with two ¾" diameter holes and two 5/8" x 14" steel pins for anchoring.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that all existing utility openings, valves, and other project installations are at their proper finished grade elevations, within areas to be paved. Provide temporary closures and protection over openings until completion of rolling operations. Remove closures at completion of the work. Set covers to grade, flush with the surface of the adjoining pavement.

3.2 SUBGRADE PREPARATION

- A. Prior to placing the bottom course of processed stone aggregate base, the prepared subgrade shall be maintained true to line and grade at all times. No placement of the processed aggregate is to commence until acceptance by the Engineer of the subgrade on which it is to be placed.
- B. The formation and protection of subgrade shall conform to the requirements of Article 2.09.01 and 2.09.03, Form 816.

3.3 BASE COURSE MATERIAL PLACEMENT/COMPACTION

- A. Install processed aggregate base material at the locations as shown on the Drawings and in accordance with Article 3.04.03, Conn DOT Form 816. Dimensions specified are after compaction.
- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).
- C. Insure thorough and proper compaction around all yard drains, catch basins, structures, utility valves, and other improvements that project above base material.

3.4 BITUMINOUS CONCRETE PAVEMENT

A. General

1. Install the bituminous concrete pavement to the lines, grades, and details shown on the Drawings. Neatly and cleanly meet and match abutting pavements. Remove all soft or yielding material below grade and replace with suitable material.
2. Thicknesses after compaction shall conform to the details on the Drawings. The pavement shall consist of the number of courses and thickness as detailed. Remove and replace areas showing deficiencies in required thickness with new material as directed by the Engineer.
3. Protect existing abutting pavement during paving operations. Replace any abutting pavement damaged during paving operations. Joint between bituminous pavement and existing portland cement concrete pavement shall be tightly compacted and pavement edge shall be of equal density to other areas of pavement.
4. Provide a minimum cross-pitch of 1/4" per foot or grade as indicated by the plan drawings for proper drainage. Ensure that there are no "low" spots that may trap water and create a slipping hazard.

B. Forms

1. Provide wood edge forms of an approved type and a minimum length of ten (10) feet for tangents and curves, unless otherwise shown on the plans. Wood forms shall be of a depth equal to the depth of the pavement and shall be securely staked and braced to the required line and grade. Note: Hand tamp edges and bevel if wood forms are not used.
2. Install wood forms along all edges of pavement to produce a clean vertical edge. Secure strips to allow for proper compaction of bituminous concrete. Do not remove edge screed strips until pavement is thoroughly compacted. Raveled edges will not be accepted. Wood forms are to be removed after the bituminous pavement has completely set.
3. All forms shall be straight, free from bends and warps at all times, and shall be cleaned thoroughly and oiled before pavement is placed against them, this cleaning and oiling being repeated daily as the forms are moved.
4. The forms shall rest firmly upon the thoroughly compacted sub-grade throughout their entire length, shall be joined neatly and tightly and staked securely to line and grade, three (3) bracing pins or stakes, each ten (10) foot length of side form, so that they will resist the pressure of the pavement and the impact of the roller without springing.

C. Placing

1. Bituminous concrete pavement shall be constructed and compacted in conformance with Conn DOT Form 816 requirements.

**SECTION 32 12 00**  
**BITUMINOUS CONCRETE PAVEMENT AND MARKINGS**

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2. Coat the edge of all abutting pavement with tack coat before installing bituminous concrete pavements. Insure that the abutting pavement has a sound, clean, straight edge. Feathering of edges and transitions between new and existing pavements is not acceptable. Protect surfaces of abutting pavement from tack coat overspray.
3. Each mixture shall be furnished and laid by means of a mechanical spreader of approved design to a depth which after final compaction shall be equal to the specified depth. In areas where the use of a mechanical spreader is impractical, as determined by the Engineer, other means of spreading and compacting may be permitted. The use of hand rakes will not be permitted. The Contractor shall use lutes where necessary.
4. After placing and compacting binder course, tack coat shall be applied prior to placement of the wearing (top) course.
5. Each mixture shall be laid only where the surface to be covered is free from loose or foreign material, dry, and only when weather conditions, in the opinion of the Engineer, are suitable.
6. The Contractor shall provide suitable means for keeping all small tools clean and free from bituminous accumulations.
7. Pavement may be laid by hand. Pavement shall be compacted by making multiple passes with a roller weighing not less than 2,000 pounds. After compaction, the thickness shall be that as specified on the drawings.

**D. Compacting**

1. Upon completion of the spreading of each mixture, the material shall be consolidated thoroughly and uniformly with self-propelled tandem rollers. The top course shall be free from roller marks.
2. Rollers used for compacting the top course shall be well balanced, self-propelled, tandem rollers, weighing between seven (7) and eight (8) tons. The roller shall have a compression under the rear wheel of between 200 and 300 pounds per linear inch of roll at a rate not exceeding 800 square yards per hour per roller. After compaction, the surface course shall have a density not less than 97% theoretical maximum density as determined by Appendix B of The Asphalt Institute Manual MS-2.
3. Locations inaccessible to the roller, the compression shall be effected with iron tampers weighing not less than twenty-five (25) pounds and having a bearing area not exceeding forty-eight (48) square inches, or other impact type equipment.
4. Perform breakdown, second and finish rolling until the bituminous concrete mixture has been compacted to the required surface density and smoothness. Continue rolling until all roller marks are eliminated. Provide a smooth compacted surface true to thickness and elevations required.
5. After final rolling, do not permit vehicular traffic on the pavement until it has cooled and hardened, and in no case sooner than 8 hours.

E. Joints for New Construction and Between Existing Pavement:

1. Carefully make joints between old and new pavements, and between successive day's work, to ensure a continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of the asphalt concrete course.
2. Construction shall be as nearly continuous as is possible. The roller shall pass over the end of the laid mixture only when a practical necessity.
3. When the operation of laying is interrupted, the end of the laid material shall be left unrolled until such time as work is resumed, in order that there be no joints throughout the project.
4. If it is necessary to roll the end of the laid mixture during construction, thus consolidating it, the joint so made shall be cut back before recommencing the operation of laying, in order to present a fresh, clean surface for contact with the newly placed material.
5. The edges of such joints shall be painted with liquid asphalt (RC-70 or MC-70) and the use of hot smoothing irons in finishing such joints, shall not be permitted.

F. Finished Surface

1. The surface of the top course of the pavement after compression shall be smooth and true to crown and grade, free from depressions, waves, bunches, overlapping seams and unevenness in surface. All new surfaces shall meet existing surfaces smoothly and evenly.
2. After the compaction of the top course, the Contractor shall check the entire paved area for depressions, using a ten (10) foot wood or metal straightedge. Any depressions greater than three-sixteenths (3/16) of an inch shall be corrected by removing the top course of the affected areas, and replacing with new material to form a true an even surface.

G. Defects: Where defects in composition, compression or finish appear in the completed work, such finished areas shall be removed to the full depth of the course and the defective material replaced with the required thickness of pavement at the expense of the contractor.

1. Patching: Remove and replace mixtures that become mixed with foreign materials and all defective areas. Cut out such areas and fill with fresh hot asphalt concrete. Compact by rolling to the required surface density and smoothness. Remove deficient areas for the full depth of the course. Cut sides perpendicular and parallel to the directions of traffic with edges vertical. Apply a tack coat before placing asphalt concrete mixture.

3.5 PAINTED PAVEMENT MARKINGS

A. Parking Areas and Roadways

1. Existing painted pavement markings shall be removed by sandblasting or milling. Painting over existing markings will not be allowed.
2. Pavement areas to be painted shall be dry and sufficiently cleaned of sand, dust and road debris so as to provide an acceptable bond between the paint and the pavement.
3. Fast drying paint shall be applied at a temperature of 120 F to 150 F at the spray gun.
4. All paint shall be performed in a neat and workmanlike manner, using approved mechanical equipment. Lines shall be sharp and clear with no feathered edging or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied as shown on the plans with no unsightly deviations.
5. After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

B. Tennis Courts

1. Conform to Section 32 18 23 - Color Seal Coat System and Court Lines.

3.6 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes cast into wheel stops. Firmly bond each dowel to wheel stop and to pavement. Extend upper portion of dowel 5 inches (125 mm) into wheel stop and lower portion a minimum of 5 inches (125 mm) into pavement.

3.7 PROTECTION/CLEAN-UP

- A. Protect all work until acceptance of the project. Replace or repair pavement if damaged prior to acceptance.
- B. Clean up all debris from installation procedures, including but not limited to bituminous concrete and base material overflow into/onto areas indicated to be lawn or other surfaces. Remove from site all excess materials, debris and equipment. Contractor shall dispose of debris material legally.
- C. Repair damage resulting from paving operation to other areas of the work.

**END OF SECTION**

SECTION 32 12 13 - PORTLAND CEMENT CONCRETE PAVEMENT AND CURB

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Form 816" shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 SUMMARY

- A. This Section includes the materials, labor, installation and incidental costs for the installation of subbase material, base materials, and portland cement concrete pavement.
  - 1. Reinforced concrete pavement
  - 2. Concrete curb
  - 3. Curb ramps
  - 4. Concrete sidewalk
- B. Coordinate the work of this Section with Section 32 12 00 - Bituminous Concrete Pavement and Markings.

1.3 RELATED SECTIONS

- A. Section 32 12 00 - Bituminous Concrete Pavement and Markings

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete pavement mix.



- C. **Material Test Reports:** From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials. Contractor shall pay for all testing of concrete materials.
- D. **Material Certificates:** Signed by manufacturers certifying that each of the following materials complies with requirements:
  - 1. Cementitious materials and aggregates
  - 2. Steel reinforcement and reinforcement accessories
  - 3. Admixtures
  - 4. Curing compounds
  - 5. Applied finish materials (i.e., traffic paint)
  - 6. Joint fillers

#### 1.5 QUALITY ASSURANCE

- A. **Materials and methods of construction shall comply with the following standards:**
  - 1. American Society for Testing and Materials (ASTM)
  - 2. American Concrete Institute (ACI)
  - 3. State of Connecticut DOT Standard Specifications (DOT Form 816-2004)
- B. **Installer Qualifications:** An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. **Manufacturer Qualifications:** Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
  - 1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- D. **Testing Agency Qualifications:** An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 shall be paid by the contractor to conduct the testing indicated, as documented according to ASTM E 548.
- D. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source. Do not change source of brands of cement, aggregate materials, or batching plant during course of work.
- E. **ACI Publications:** Comply with all ACI requirements unless modified by the requirements of the Contract Documents.
- F. **Concrete Testing Service:** Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Forms shall conform to Article 8.11.03-3 and 9.21.03-3 of ConnDOT Form 816, latest revision.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets, galvanized or epoxy coated.
- B. Reinforcement Bars: ASTM A 615, Grade 60, deformed bars, galvanized or epoxy coated.
- C. Plain Steel Wire: ASTM A 82, as drawn, galvanized or epoxy coated.
- D. Joint Dowel Bars: ASTM A 615, Grade 60, plain steel bars, galvanized or epoxy coated.
- E. Tie Bars: ASTM A 615, Grade 60, deformed, galvanized or epoxy coated.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- G. Epoxy coated bar reinforcement shall conform to Form 816 and the requirements of ASTM A 615M, Grade 420 and shall be epoxy coated to the requirements of ASTM D 3963/D 3963M.
- H. Galvanized bar reinforcement shall conform to Form 816 and the requirements of ASTM A 615/A 615M, Grade60, (420) and be galvanized, after fabrication, to the requirements of ASTM 767/A \*767M, Class 1, including supplemental requirements. Dowels and tie bars

for masonry facing and for granite curbing shall be galvanized, after fabrication, in accordance with ASTM A 706/A 706M.

### 2.3 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
- B. Concrete: Conform to the requirements of Form 816-2004, Article M.03.01, Class "C" and ASTM C-94. Batch mixing at project site not acceptable.
- C. Compressive strength: 3,000 psi at 28 days.
- D. Entrained air: 5 to 7%.
- E. Reactive aggregates and calcium chloride are not allowed.
- F. Water: Potable.

### 2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

### 2.5 CURING MATERIALS

- A. Conform to Article 4.01.03, Item F7 "Curing", Form 816-2004.

### 2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Premolded Joint Filler Strips: ASTM D-994, premolded, resilient non-extruding joint filler conforming to the requirements of AASHTO M213.
- C. Thickness and depth of expansion- and isolation-joint filler as indicated on the drawings.

D. Pavement-Marking Paint: Latex, water-base emulsion; ready mixed; complying with FS TT-P-1952.

1. Color: Blue for handicapped requirements, yellow for fire lanes, white elsewhere.

## 2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement in conformance with Section 31 23 16 - Earthwork.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

### 3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

### 3.4 JOINTS

- A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
  - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
  - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  - 2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
  - 3. Provide tie bars at sides of pavement strips where indicated.
  - 4. Use a bonding agent or epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
  - 1. Locate expansion joints at intervals of 50 feet (15.25 m), unless otherwise indicated.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
  5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
    - a. Radius: 1/4 inch (6 mm).
    - b. Radius: 3/8 inch (10 mm).
  2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
1. Radius: 1/4 inch (6 mm).
  2. Radius: 3/8 inch (10 mm).

### 3.5 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

- C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery, at project site, or during placement.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
  - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Engineer.
- I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations.
- J. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
  - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  2. Do not use frozen materials or materials containing ice or snow.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- M. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.6 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Finishing: Conform to Article 4.01, Form 816.
  1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.



- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Conform to Form 816-2004, Article 4.01.

### 3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
  - 1. Elevation: 1/4 inch (6 mm).
  - 2. Thickness: Plus 3/8 inch (9 mm), minus 1/4 inch (6 mm).
  - 3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/4 inch (6 mm).
  - 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
  - 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
  - 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
  - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
  - 8. Joint Spacing: 3 inches (75 mm).
  - 9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  - 10. Joint Width: Plus 1/8 inch (3 mm), no minus.

### 3.10 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

### 3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
- B. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.

- C. Testing Services: Testing shall be performed according to the following requirements:
1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
  2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
  3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
  4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
  5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
  6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
  7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  8. When total quantity of a given class of concrete is less than 50 cu. yd. (38 cu. m), Engineer may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.
  9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
  10. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).

- D. Test results shall be reported in writing to, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as the sole basis for approval or rejection.
- F. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

### 3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.
- B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION**

SECTION 32 12 44 - REINFORCED TURF

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Work Included:

1. Provide and install sandy gravel base as shown on drawings, to provide adequate support for project design loads. See 2.2 Materials.
2. Provide Grasspave2 Paving System products including Grasspave2 units, Hydrogrow soil polymer, and installation per the manufacturer's instructions furnished under this section.
3. Provide and install clean sharp sand to fill the Grasspave2 units, when needed.
4. Provide and install grass by using sod.

B. Related Work:

1. Section 31 23 16 – Earthwork
2. Section 32 12 13 – Portland Cement Concrete Pavement and Curb.

1.3 Quality Assurance

- A. Installation: Performed only by skilled work people with satisfactory record of performance on landscaping or paving projects of comparable size and quality.

1.4 Submittals

- A. Submit manufacturer's product data and installation instructions.
- B. Submit a 10" x 10" section of Grasspave2 material for review. Reviewed and accepted samples will be returned to the contractor.
- C. Submit material certificates for base course and sand fill materials.

1.5 Delivery, Storage, and Handling

- A. Protect Grasspave2 units from damage during delivery and store under tarp when time from delivery to installation exceeds one week. Keep Hydrogrow in a dark and dry location.

1.6 Project Conditions

- A. Review installation procedures and coordinate Grasspave2 work with other work affected. Generally, Grasspave2 is installed at the same time as project grass installation, nearly the last site construction activity.
- B. All hard surface paving adjacent to Grasspave2 areas, including concrete walks and asphalt paving, must be completed prior to installation of Grasspave2.
- C. Gradients for grass porous paving surfaces can vary from flat to 20%, depending upon vehicle types to use the surface. Please note that firelanes, or other emergency vehicles, will generally require a gradient that is less than 6%. If there are any questions regarding existing gradients on this project, please contact the Project Designer, or Invisible Structures, Inc.
- D. Cold weather:
  - 1. Do not use frozen materials or materials mixed or coated with ice or frost. Be careful in handling rolls of Grasspave2 in temperatures below 50 degrees F, as product connectors become stiff and can separate, and the individual units will retain the roll curl until warmed to room temperature (usually by sun).
  - 2. Do not build on frozen work or wet, saturated or muddy subgrade.
- E. Protect partially completed paving against damage from other construction traffic when work is in progress, and until grass root system has matured (about 3 to 4 weeks). Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.
- F. Protect adjacent work from damage during Grasspave2 installation.

PART 2 - PRODUCTS

2.1 Availability

- A. Manufacturer: (Grasspave2, Hydrogrow) Invisible Structures, Inc., 1597 Cole Blvd., Suite 310, Golden, CO 80401. Call from USA and Canada 800-233-1510 toll free, International 303-233-8383, Fax 303-373-1223 or approved equal.

2.2 Materials

- A. Base Course: Sandy gravel material from local sources commonly used for road base construction, passing the following sieve analysis:

<u>% Passing</u>	<u>Sieve Size</u>
100	3/4"
85	3/8"
60	#4
30	#40
< 3	#200

1. Sources of the material can include either "pit run" or "crusher run." Crusher run material will generally require sharp sand to be added to mixture (30 to 40% by volume) to ensure long term porosity. If there is difficulty in finding local sources to meet this sieve analysis, and alternative mixture can be created by mixing 2/3 crushed drainage rock (0.75" dia) with 1/3 concrete or river sand.
  2. Selected materials should be nearly neutral in pH (range from 6.5 to 7.2) to provide adequate root zone development for turf.
  3. Alternative materials such as crushed shell, limerock, and/or crushed lava may be considered for base course use, provided they are mixed with sharp sand (33%), and brought to proper compaction. (Crushed shell and limerock alone can set up like concrete without sand added.)
- B. Hydrogrow Mix: A mixture made from several commercial products including: 1) cross-linked polyacrylimide (<0.1%) polymer, which is non-toxic and neutral in pH, and will absorb 150 to 350 times its weight in water from most tap sources; 2) ZeoPro zeolite mineral, amended with small amounts of starter fertilizers, from Zeoponix, Inc.; 3) Isolite porous ceramic, designed to hold large amounts of water without physical degradation or change of size of particle, from Summitomo Group; 4) and agglomerated Humate, a natural source of nutrients and micronutrients, from Tri-C Enterprises.
- C. Grasspave2 Grass Paving Units: Lightweight injection-molded plastic units 0.5x0.5x0.025 m (20"x20"x1" high, 2.7 ft<sup>2</sup> each) with hollow rings rising from a strong open grid allowing maximum grass root penetration and development. The plastic shall be 100% post-consumer recycled plastic resins, predominately HDPE, with minimum 3% carbon black concentrate added for UV protection.
- Loading capability is equal to 402 kg/cm<sup>2</sup> (5700 psi) when filled with sand, over an appropriate depth of roadbase. Standard color is black. Unit weight = 510 g (18 oz.), volume = 8% solid. Units may also be shipped in pre-assembled into rolls that vary from 10 square meters (108 sf) to 125 square meters (1345 sf).
- D. Sand: Obtain clean sharp sand (washed concrete sand) to fill the 25 mm (one inch) high rings and spaces between the rings when seeding or using 13 mm (half inch) thick sod (soil thickness).
- E. Grass: Use sod species resistant to wear by traffic generally a Blue/Rye/Fescue mix used in northern climates.
1. Sod: Use 13 mm (0.5") thick (soil thickness) rolled sod from a reputable local grower. Species should be wear resistant, free from disease, and in excellent condition. Sod shall be grown in sand or sandy loam soils only. Sod grown in soils of clay, silt, or high organic materials such as peat, will not be accepted.
- F. Fertilizer: A commercial "starter" fertilizer, with Guaranteed Analysis of 17-23-6, or as recommended by local grass supplier, for rapid germination and root development.

### PART 3 - EXECUTION

#### 3.1 Inspection

- A. Examine subgrade and base course installed conditions. Do not start Grasspave2 installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients.
- B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Project Manager for resolution.

#### 3.2 Preparation

(Ensure that subbase materials are structurally adequate to receive designed base course, wearing course, and designed loads. Ensure that grading and soil porosity of the subbase will provide adequate subsurface drainage.)

- A. Place base course material over prepared subbase to grades shown on plans, in lifts not to exceed 150 mm (6"), compacting each lift separately to 95% Modified Proctor. Leave 35 mm (1.5") for Grasspave2 unit and sand/sod fill to Final Grade.
- B. Spread all Hydrogrow mix provided (spreader rate = 2.25 kg per 100 m<sup>2</sup> (10 lbs per 1000 ft<sup>2</sup>) evenly over the surface of the base course with a hand-held, or wheeled, rotary spreader. The Hydrogrow mix should be placed immediately before installing the Grasspave2 units to assure that the polymer does not become wet and expanded when installing the units.

#### 3.3 Installation of Grasspave2 Units

- A. Install the Grasspave2 units by placing units with rings facing up, and using pegs and holes provided to maintain proper spacing and interlock the units. Units can be easily shaped with pruning shears or knife. Units placed on curves and slopes shall be anchored to the base course, using 16d Common nails with fender washer, as required to secure units in place. Tops of rings shall be between 6 mm to 13 mm (0.25" to 0.5") below the surface of adjacent hard-surface pavements.
- B. Install sand in rings as they are laid in sections by "backdumping" directly from a dump truck, or from buckets mounted on tractors, which then exit the site by driving over rings already filled with sand. The sand is then spread laterally from the pile using flat bottomed shovels and/or wide "asphalt rakes" to fill the rings. A stiff bristled broom should be used for final "finishing" of the sand. The sand must be "compacted" by using water from hose, irrigation heads, or rainfall, with the finish grade no less than the top of rings and no more than 6 mm (0.25") above top of rings.

3.4 Installation of Grass

- A. Install thin sod directly over sand filled rings, filled no higher than the top of the rings. Sod strips should be placed with very tight joints. Sodded areas must be fertilized and kept moist during root establishment (minimum of 3 weeks). Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated and established well below the Grasspave2 units.

3.5 Protection

- A. Sodded areas must be protected from any traffic, other than emergency vehicles, for a period of 3 to 4 weeks, or until the root system has penetrated below the Grasspave2 units.

3.6 Cleaning

- A. Remove and replace segments of Grasspave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.
- B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

**END OF SECTION**



SECTION 32 14 13 - UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Concrete pavers set in aggregate setting bed.
- B. Related Sections include the following:
  - 1. Section 31 22 13 - Formation of Subgrade
  - 2. Section 31 23 16 - Earthwork
  - 3. Section 32 11 23 - Processed Aggregate Base
  - 4. Section 33 46 23.16 - Broken Stone

1.3 SUBMITTALS

- A. Product Data: For concrete pavers.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of unit paver indicated.
- C. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

- B. **Installer Qualifications:** An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
  
- C. **Mockups:** Before installing unit pavers, build mockups for each form and pattern of unit pavers required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:
  - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect and Engineer.
  - 2. Notify Architect and Engineer seven days in advance of dates and times when mockups will be constructed.
  - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
  - 4. Obtain Architect's and Engineer's approval of mockups before starting unit paver installation.
  - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6. Demolish and remove mockups when directed.
  - 7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
  - 1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.
  - 2. Store materials on elevated platforms, under cover, and in a dry location.

1.6 PROJECT CONDITIONS

- A. **Cold-Weather Protection:** Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Preferred Product: Series 3000 Granitestone Paver as manufactured by Unilock (800-UNILOCK), 51 International Blvd., Brewster, NY, 10509, ph: Tel (845) 278-6700, fax (845) 278-6788; [www.unilock.com](http://www.unilock.com)
  - 1. Color: slate
  - 2. Size: 6" x 6" x 2 3/4"
  
- B. Alternate Product: Square Classique Paver in Granitex, as manufactured by TECHO-BLOC, St-Hubert, Quebec, Phone: 800-463-0450
  - 1. Color: charcoal #200010
  - 2. Size: 6" x 6" x 2.4"
  - 3. Distributed by:
    - a) Earth Materials LLC, Orange, CT. Phone: 203-799-2322.
    - b) New England Silica, Inc., South Windsor, CT. Phone: 860-289-7778.
    - c) Washington Concrete Products Inc., Plainville, CT. Phone: 860-747-5242
  
- C. Alternate Product: Prest Paver, Tudor Finish, as manufactured by Hanover Architectural Products, 240 Bender Road, Hanover, PA, 17331, ph: (717) 637-0500, fax: (717) 637-7145; [www.hanoverpavers.com](http://www.hanoverpavers.com)
  - 1. Color: superblack
  - 2. Size: 6" x 6" x 2 3/8"

2.2 UNIT PAVER STANDARDS

- A. Concrete Pavers: Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated.
  
- B. Cementitious Material: Portland Cements shall conform to ASTM Specification C0150.
  
- C. Aggregates: Aggregates shall conform to ASTM Specification C-33 for Normal Weight Concrete Aggregate (no expanded shale or lightweight Aggregates) except that grading requirements shall not necessarily apply.
  
- D. Other Constituents: Color pigments, air-entraining agents, integral water repellants, finely ground silica, etc., shall be previously established as applicable, or shall be previously established as suitable for use in concrete.

E. Physical Requirements:

1. Compressive Strength - At the time of delivery to the work site, the average compressive strength shall not be less than 8,000 psi, with no individual unit strength less than 7,200 psi as per ASTM Specification C936-82. Testing procedures shall be in accordance with ASTM Specification C-140.
2. Absorption - The average absorption shall not be greater than five percent (5%) with no individual unit absorption greater than seven percent (7%) as required by ASTM Specification C-936-82.
3. Resistance to Freezing and Thawing - The manufacturer shall satisfy the purchaser either by proven field performance or a laboratory freezing and thawing test that the paving units have adequate resistance to freezing and thawing. If a laboratory test is used when testing in accordance with Section 8 of Method C67, specimens shall have no breakage and not greater than 1.0% loss in dry weight of any individual unit when subjected to 50 cycles of freezing and thawing.

2.3 AGGREGATE SETTING BED MATERIALS

- A. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.
- B. Graded Aggregate for Subbase: ASTM D 2940, subbase material.
- C. Graded Aggregate for Base: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- D. Graded Aggregate for Base: ASTM D 2940, base material.
- E. Geotextile: Woven or nonwoven geotextile manufactured from polyester or polypropylene fibers, with a permeability rating 10 times greater than that of soil on which paving is founded and an apparent opening size small enough to prevent passage of fines from leveling course into graded aggregate of base course below.

2.4 GRANULAR BASE

- A. The graded aggregate for the granular base shall comply with ASTM Specification 2940 or equivalent for base material.
- B. Where materials of varying quality are considered suitable for base construction, the better quality materials should be used for the upper 4" (100mm) of the base layer with the poorer quality material being used lower down.

2.5 BEDDING SAND LEVELING COURSE

- A. Bedding sand leveling course shall comprise a sound, sharp, natural, clean, washed, well graded sand in compliance with ASTM Specification C33 and the following grading limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8" (9.52 mm)	100
No. 4 (4.75 mm)	95 - 100
No. 8 (2.36 mm)	80 - 100
No. 16 (1.18 mm)	50 - 85
No. 30 (500 um)	25 - 60
No. 50 (300 um)	20 - 30
No. 100 (150 um)	5 - 15
No. 200 (75 um)	0 - 10

- B. The bedding sand shall be dry, sharp and free of organics and deleterious soluble salts or other contaminants likely to cause efflorescence.
- C. The sand shall be uniform moisture content when screeded and shall be protected against rain when stockpiled on site prior to screeding.
- D. The moisture content shall be in the range of 4 - 8%.

2.6 JOINTING SAND

- A. Jointing Sand shall be in compliance with ASTM specifications C144 - gradation for 1/8" (3mm) joints. The jointing sand shall be free of organics and soluble salts or contaminants likely to cause efflorescence.
- B. Jointing sand shall comply with the following grading limits:

<u>Sieve Size</u>	<u>Natural Sand Percent Passing</u>	<u>Manufactured Sand Percent Passing</u>
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 - 100	95 - 100
No. 16 (1.18 mm)	70 - 100	70 - 100
No. 30 (600 um)	40 - 75	40 - 75
No. 50 (300 um)	10 - 35	20 - 40
No. 100 (150 um)	2 - 15	10 - 25
No. 200 (75 um)	0	0 - 10

**PART 3 - EXECUTION**

**3.1 SITE INSPECTION**

- A. Examine the substrate on which pavers will be laid and the conditions under which the work will be performed. Notify the owner or consultant of any unsatisfactory conditions. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. All subdrainage or underground services within the pavement area must be completed with subgrade preparation and before the commencement of base construction.
- C. Examine curb installation and confirm with owner or owner's representative and Contractor that curb installation is complete. Notify the owner or owner's representative of any unsatisfactory conditions with curb installation. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION/VERIFICATION OF SUBGRADE**

- A. The Sub-Contractor and Contractor shall ensure that the prepared subgrade is protected from damage from inundation by surface water and damage by other trades.
- B. No traffic shall be allowed to cross the prepared subgrade.
- C. Repair of any damage resulting shall be the responsibility of the Contractor and shall be repaired in a satisfactory manner.
- D. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase for unit pavers.

**3.3 PAVER VISUAL INSPECTION**

- A. All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor cracks incidental to the usual methods of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
- B. Contractor shall not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

**3.4 INSTALLATION, GENERAL**

- A. Mix pavers from three pallets or cubes minimum, as they are placed, to produce uniform blend of colors and textures.

- B. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting and block splitting is not acceptable.
- C. Joint Pattern: Running Bond
- D. Tolerances: Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.
- E. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

### 3.5 AGGREGATE SETTING-BED PAVER APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 1557 laboratory density.
- B. Place geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
- C. Place aggregate subbase/base in thickness or thicknesses as indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.
- D. Place aggregate subbase/base over compacted subgrade. Provide compacted thickness indicated. Compact subbase/base to 100 percent of ASTM D 1557 maximum laboratory density and screed to depth required to allow setting of pavers.
- E. Place geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
- F. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- G. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.
- H. Set pavers with a minimum joint width of 1/16 inch (1.6 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
  - 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

- I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
  - 1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
  - 2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches (900 mm) of the laying face. Cover open layers with nonstaining plastic sheets overlapped 48 inches (1200 mm) on each side of the laying face to protect it from rain.
- J. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- K. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- L. Repeat joint-filling process 30 days later.

**3.7 REPAIR, CLEANING, AND PROTECTION**

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: wash and scrub clean.

**END OF SECTION**



SECTION 32 15 41 - STONE SCREENINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the contract, including General Conditions and Special Provisions, and Division One General Requirements apply to the work specified in this section.
- B. "Form 816" shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Provide and install a processed stone aggregate base on a prepared subgrade for stone screening walkways as shown on the drawings and as specified herein.
- B. Provide top course (one course) of stone screenings for indicated walkways as shown on the Drawings and as specified herein.

1.3 RELATED SECTIONS

- A. Section 32 11 23 - Processed Aggregate Base

1.4 SUBMITTALS

- A. Submit certified test reports and materials certificates, for products specified in this Section, indicating compliance of all proposed materials with specified requirements.

1.5 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and shall be paid for by the Contractor. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All retesting in these areas shall be paid for by the Contractor.

- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.

#### 1.6 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work. Conform to Article 9.43.01 and 9.43.03, Form 816 for dust control. No claim for extra compensation will be allowed. All costs for dust control as directed by the Engineer shall be borne by the Contractor and included in the contract bid.

### PART 2 PRODUCTS

#### 2.1 PROCESSED STONE AGGREGATE

- A. Conform to Article M.05.01, Form 816.

#### 2.2 STONE SCREENINGS

- A. Conform to M.01.01 - Gradation Table, Form 816 for stone "screenings".

### PART 3 EXECUTION

#### 3.1 SUBGRADE PREPARATION

- A. Prior to placing the bottom course of processed stone aggregate base, the prepared subgrade shall be maintained true to line and grade, at all times. No placement of the processed aggregate is to commence until acceptance by the Engineer of the subgrade on which it is to be placed.
- B. The formation and protection of subgrade shall conform to the requirements of Article 2.09.01 and 2.09.03, Form 816.

#### 3.2 BASE COURSE MATERIAL PLACEMENT/COMPACTION

- A. Install processed aggregate base material at the locations as shown on the Drawings and in accordance with Article 3.04.03 of Form 816. Dimensions specified are after compaction.
- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).

3.3 STONE SCREENINGS PLACEMENT/COMPACTION

- A. Install stone screenings material at locations as shown on the Drawings and in accordance with Article 4.11.03, Form 816. Dimensions specified are after compaction. Tolerances are plus or minus 1/4".
- B. Edges shall be clean and straight, true to the grades, alignment and locations shown on the Drawings.

3.4 PROTECTION/CLEAN UP

- A. Maintain proper drainage to prevent washouts and flooding of surface. Protect from damage and make repairs as required.
- B. Protect all work until acceptance of the project. Replace or refinish the walkway surfaces if damaged prior to acceptance.
- C. Clean up all debris from installation procedures, including but not limited to stone screenings overflow into/onto areas indicated to be lawn or other surfaces.

**END OF SECTION**

SECTION 32 17 26 - DETECTABLE/TACTILE WARNING SURFACES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. This Section specifies furnishing and installing Cast In Place Detectable/Tactile Warning Surface Tiles where indicated.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Samples for Verifications Purposes: Submit two (2) tile samples minimum 6"x6" of the kind and color proposed for use.

1.4 RELATED SECTIONS

- A. Section 03 30 01 – Portland Cement Concrete (Site)

1.5 QUALITY ASSURANCE

- A. Provide cast in Place Detectable/Tactile Warning Surface Tiles and accessories as produced by a single manufacturer with a minimum of three (3) years experience in the manufacturing of Cast In Place Detectable/Tactile Warning Surface Tiles.
- B. Installer's Qualifications: Engage an experienced Installer certified in writing by Cast In Place Detectable/Tactile Warning Surface Tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.
- C. Americans with Disabilities Act (ADA): Provide Surface Applied Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings in the walking surfaces section of the Americans with Disabilities Act.
- D. Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Surfaces Tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an

in-line pattern of truncated domes measuring nominal 0.2'' height, 0.9'' base diameter, and 0.45'' top diameter, placed center-to-center 2.35'' as measured on a diagonal and 1.67'' as measured side by side. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40-90 deg. raised points 0.045'' high, per square inch.

E. Dimensions:

1. Length and Width: As shown as plans
2. Depth: 1.375 (1 3/8'') +/- 5% max.
3. Face Thickness: 0.1875 (3/16'') +/- 5% max.
4. Warpage of Edge: 0.5% max.
5. Embedment Flange Spacing: shall be no greater than 3.1''

F. Water Absorption of Tile when tested by ASTM D 570-98: not to exceed 0.05%.

G. Slip Resistance of Tile when tested by ASTM C 1028-96: the combined Wet and Dry Static Co-Efficients of Friction not to be less than 0.80 on top of domes and field area.

H. Compressive Strength of Tile when tested by ASTM D 695-02a: not to be less than 28,000 psi.

I. Tensile Strength of Tile when tested by ASTM D 638-03: not to be less than 19,000 psi.

J. Flexural Strength of Tile when tested by ASTM D 790-03: not to be less than 25,000 psi.

1.6 DELIVERY, STORAGE AND HANDLING

A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

B. Cast In Place Detectable/Tactile Warning Surface Tiles shall be delivered to location at building site for storage prior to installation.

C. Environmental Conditions and Protection: Maintain minimum temperature of 40 degrees F in spaces to receive Cast In Place Detectable/Tactile Warning Surface Tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

1.7 GUARANTEE

- A. Cast In Place Detectable/Tactile Warning Surface Tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and loosening of tiles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Surface Tile specified is based on Armor-Tile manufactured by Engineered Plastics Inc. (800-682-2525). Existing engineered and field tested products, which have been in successful service for a period of three (3) years and which comply with all requirements, may be considered as an approved equal.

- 2.2 COLOR: To be selected by the Architect and Engineer from standard product color palette.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to placement of the Cast In Place Detectable/Tactile Warning Surface Tile system, review manufacturer and contract drawings and refer any and all discrepancies to the Engineer.
- B. The factory-installed plastic sheeting shall remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.
- C. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. The tile shall be placed true and squared to the curb edge in accordance with the contract drawings. The Cast In Place Detectable/Tactile Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The tile field level (base of truncated dome) shall be set flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
- D. Immediately after placement, the tile elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water to drain as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.
- E. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.

- F. During and after the tile installation and the concrete curing stage, there shall be no walking, leaning or external forces placed on the tile that may rock the tile causing a void between the underside of tile and concrete.
- G. Following the concrete curing stage, protective plastic wrap is to be removed from the tile surface by cutting the plastic sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft brass wire brush will clean the residue without damage to the tile surface.

### 3.2 CLEANING, PROTECTION AND MAINTENANCE

- A. Protect tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.
- B. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- C. Clean Tactile Tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tactile Tile by method specified by Tactile Tile manufacturer.
- D. Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface. It is recommended to perform annual inspections for safety and tile integrity.

**END OF SECTION**

SECTION 32 18 23 - COLOR SEAL COAT SYSTEM AND COURT LINES (SITE)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Under these items, the Contractor shall apply a color seal coat system and painted lines to the asphaltic pavements in accordance with the Drawings, Specifications and at the direction of the Engineer.
  - 1. TENNIS COURT LAYOUTS shall conform to the Drawings as indicated.
  - 2. Each tennis court color seal coat system applied and accepted shall include the cost of furnishing all labor, materials, equipment and incidental expenses necessary to complete the work, including preparation of surfaces, patching mix, resurfacer coats, intermediate coats, wearing coats and painted lines, in accordance with the Drawings and Specifications to the satisfaction of the Engineer.
  - 3. PAINTED TENNIS COURT LINES applied and accepted shall include the cost of furnishing all labor, materials, equipment and incidental expenses necessary to complete the work, including preparation of the surface and the application of painted court lines and numbers, in accordance with the Drawings and Specifications to the satisfaction of the Engineer.

1.3 RELATED SECTIONS

- A. Section 32 12 00 - Bituminous Concrete Pavement and Markings

1.4 SUBMITTALS

- A. Submit complete details of the color seal coat system proposed to be used for approval. The specifications and information (products or systems, manufacturer's names, product description, technical and laboratory data, mixing information, methods of application, rates and all other data) as may be required to demonstrate to the satisfaction of the Engineer that the color seal coat system proposed for use meets the requirements of these specifications.
- B. Submit three (3) color paint chips/samples of each color paint required for approval. Final color selection shall be made by the Engineer after review with the Owner.



## 1.5 QUALITY ASSURANCE

- A. All materials shall be manufactured by a nationally recognized producer of these products and installation shall be in accordance with the manufacturer's current printed recommendations.
- B. Include on Label and all Containers:
  - 1. Manufacturer's name
  - 2. Type of coating
  - 3. Manufacturer's stock number
  - 4. Color (if applicable)
  - 5. Instructions for reducing (where applicable)
  - 6. Applicable Federal specification number
- C. The contractor shall furnish a technical advisor, who shall be fully knowledgeable of all equipment operations and application and cleaning techniques, to oversee painting and color seal coat operations.
- D. Regulatory Requirements
  - 1. All paint coatings shall be certified lead-free and comply with current State and Federal VOC regulations/restrictions.
  - 2. All paint coatings in public and fire protected areas shall have a Flame Spread Classification in compliance with State Building Codes and/or Regulations.

## 1.6 USE OF PREMISES

- A. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
  - 1. Limits: Confine paint operations to areas indicated on the Drawing for color seal coat system, and court lines.
  - 2. Access to Site: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of access routes.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 PAINT SUBSTITUTION

- A. A written request for paint substitution, along with manufacturer's data sheets shall be submitted for approval a minimum of two (2) weeks prior to the intended date of paint application. All paint substitutions must conform to Section 01600 and be approved in writing prior to ordering and delivery.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
- B. Store materials at temperatures between 45 and 90 degrees Fahrenheit in a well ventilated area, out of direct sunlight. Protect from freezing.
- C. Comply with health and fire regulations.
- D. Take precautionary measures to prevent fire hazards and spontaneous combustion.
- E. Comply with manufacturer's current specifications.

PART 2 - PRODUCTS

2.1 COLOR SEAL COAT SYSTEM

- A. Materials: The color seal coat system consists of multiple resurfacer coats, two (2) intermediate coats and two (2) wearing coats. Patching mix shall be installed as necessary and as described under Item 3.2.D.
- B. Patching Mix: (also known as Leveling Mixture) The patching mix shall be combined in the following proportions:
  - 2 gal. Silica Sand
  - 2 gal. Asphaltic Emulsion Resurfacer (non-asbestos) - undiluted
  - 1/2 gal. Asphaltic Emulsion Tack Coat - undiluted or
  - "Acrylic Patch Binder 920-39" as manufactured by California Products Corp.
- C. Resurfacer Coats (also known as Filler Coat)
  - 1. Resurfacer coats shall consist of a mixture of black fibrated asphalt emulsion resurfacer and No. 40-60 mesh Silica sand. The resurfacer shall be "Acrylic Resurfacer 920-29" as manufactured by California Products Corp.; "Laykold Resurfacer" as manufactured by Advanced Polymer Technology; or approved equal.
  - 2. The sand shall be mixed with the resurfacer at the rate of 600 pounds of sand to 55 gallons of undiluted resurfacer, or at such other rate as the manufacturer shall require to meet job conditions. Water shall be added per manufacturer's specifications.

D. Intermediate Coats

1. The intermediate coats shall be full color acrylic filler coatings consisting of colored acrylic latex emulsion compounded with Silica sand. The intermediate coats shall be "DecoColor Plus with sand 920-37" as manufactured by California Products Corp.; Laykold "Cushioncoat" as manufactured by Advanced Polymer Technology; or approved equal.
2. Sand shall be No. 80-100 mesh Silica sand. Sand and water shall be added per manufacturer's specifications.

E. Wearing Coats

1. The wearing coats shall be full color acrylic latex emulsion. The wearing coats shall be either "Plexicrome Acrylic Finish Coat" or "DecoColor MP 920-27" as manufactured by California Products Corp.; "Laykold Colorcoat" as manufactured by Advanced Polymer Technology; or approved equal.
  - a. Water shall be added per manufacturer's specifications.

- F. Colors: Colors for intermediate and wearing coats shall be standard "tan" and a "blue" as selected and approved by Owner and Engineer.

2.2 PAINTED COURT LINES ON COLOR SEAL COAT

- A. Line paint to be installed on the color seal coat shall be equal to Fed. Spec. TT-P19a. The paint shall be a 100% acrylic emulsion. The line paint shall be thinned with water only. The paint shall be suitable for application by brush, spray or roller.
- B. The paint shall be equal to:
  1. "Striping Paint 920-22" as manufactured by California Products Corporation, Cambridge, MA., Phone: (800) 225-1141.
  2. Laykold Line Paint as manufactured by Advanced Polymer Technology, Phone: (724) 452-1330
  3. Or approved equal.
- C. Line color shall be white.

- 2.3 ACCESSORY MATERIALS: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finish specified shall be of commercial quality.

PART 3 - EXECUTION

3.1 GENERAL

- A. Applicators shall be approved and authorized by the respective product manufacturers.
- B. Field Samples: The initial application area of each coating system color shall be prepared for the Engineer's approval of color, texture and workmanship. Do not proceed with subsequent areas until initial application is approved.
- C. Thoroughly examine surfaces scheduled to be finished prior to commencement of work. Report in writing any condition that may potentially affect proper application. Do not commence work until such defects have been corrected. Beginning of finish installation means acceptance of existing conditions.
- D. Prepare all surfaces in accordance with product/coating manufacturer's recommendations and the requirements in this Specification.
- E. Protect elements surrounding the work of this Section from damage or disfiguration. Repair damage to other surfaces caused by the work of this Section.
- F. Provide drop cloths, shields, and protective methods to prevent spray or drippings from disfiguring other surfaces.
- G. Do not apply finishes in areas where dust is being generated.
- H. No painting shall be done when the temperature is below 55° Fahrenheit or if rain is expected within 24 hours. Painting shall also conform to the Dew Point Chart as indicated below.
- I. Dew Point: Temperature at which moisture will condense on surface. No coatings should be applied unless surface temperature is a minimum of 5 degrees Fahrenheit above the dew point. Temperature must be maintained during curing. To calculate the proper surface temperature, use the chart below as follows:

Example: If air temperature is 70 degrees Fahrenheit and relative humidity is 65%, the dew point is 57 degrees Fahrenheit. No coating should be applied unless the surface temperature is 62 degrees Fahrenheit minimum.

The following chart shall serve as a guide in finding the minimum allowable temperature for paint application under the various items of this contract.

DEW POINT CHART (FAHRENHEIT)

AMBIENT AIR TEMPERATURE IN DEGREES F

	20	30	40	50	60	70	80	90	100	110	
PERCENT RELATIVE HUMIDITY	90	18	28	37	47	57	67	77	87	97	107
	85	17	26	36	45	55	65	75	84	95	104
	80	16	25	34	44	54	63	73	82	93	102
	75	15	24	33	42	52	62	71	80	91	100
	70	13	22	31	40	50	60	68	78	88	96
	65	12	20	29	38	47	57	66	76	85	93
	60	11	19	27	36	45	55	64	73	83	92
	55	9	17	25	34	43	53	61	70	80	89
	50	6	15	23	31	40	50	59	67	77	86
	45	4	13	21	29	37	47	56	64	73	82
	40	1	11	18	26	35	43	52	61	69	78
	35	-2	8	16	23	31	40	48	57	65	74
30	-6	4	13	20	28	36	44	52	61	69	

3.2 COLOR SEAL COAT SYSTEM

A. Restrictions

1. Before the color seal coat system is applied, the asphaltic surface to receive the system shall have cured for a minimum of thirty (30) days.
2. The surface temperature shall be taken using a surface thermometer. The Contractor shall take readings every sixty (60) feet in all directions. If the average surface temperature is below fifty-five degrees fahrenheit (55° F.) application will not be permitted. If the average surface temperature is above eighty degrees fahrenheit (80° F.), the surface shall be waterfogged before application will be permitted.

B. Surface Cleaning and Preparation

1. The surface shall be cleaned of all dirt, loose sand, and stone. The Contractor shall power wash the surface clean to the satisfaction of the Engineer prior to applying the color seal coat system.
2. Before application of each coat, the surface shall be blown free of all dirt and foreign matter and shall be free from standing water and oils.

C. Application of Materials

1. All painted areas of color seal coat shall be carefully laid out as indicated on the Drawings and defined on the surface by chalk markings before being painted.

2. All materials shall be mixed at the site unless otherwise permitted by the Engineer. If the Contractor is granted permission to mix any material off the site he shall arrange with the Engineer to have a representative of the Engineer present during the mixing operations. The mixed materials shall be homogeneous, segregation before or during application will not be permitted.
3. All materials shall be applied by approved hand or mechanical squeegees. Each completed application shall be smooth, even textured, free from ridges, valleys and tool marks.
4. All painting shall be performed in a neat and workmanlike manner. Precautions shall be taken to prevent tracking by tires of the Contractors equipment and/or tracking by workers. Containers and brushes shall be protected in warm weather, to prevent damage to paint and brushes.
5. After application of the each coat, the paint shall be protected from tires of the Contractor's equipment and/or tracking by workers for a time at least equivalent to the drying time of the paint.

**D. Resurfacer Coats (also known as Filler Coats)**

1. The purpose of the resurfacer coats is to fill the surface voids of the asphalt pavement. To this end the resurfacer coat material shall be applied in multiple coats until the surface of the asphalt is free of voids and no telegraphing of the aggregate in the asphalt is visible. A minimum of two coats shall be applied. However, the Contractor shall apply as many additional coats as may be required to fulfill the above requirements. The resurfacer may be diluted with water in accordance with the manufacturer's specifications to obtain workability.
2. The application of the resurfacing coat shall be parallel in one direction of the courts, a second application may be made at ninety (90) degrees to the first coat.
3. Prior to the application of the resurfacer coats, the entire area shall be flooded with water and allowed to drain. Any areas holding over one-sixteenth inch (1/16") (thickness of a nickel) depth of water shall be leveled with a PATCHING MIX and allowed to thoroughly cure. Patching mix shall be applied in a maximum of (1/4") one-quarter inch lifts. A maximum of (1/2") one-half inch total patch (2 lifts) shall be allowed. This process of water flooding and leveling shall be repeated until all depressions over one-sixteenth inch (1/16") have been eliminated.

**E. Intermediate Coats**

1. Two intermediate coats shall be applied. The total amount of material to be applied shall be 0.10 to 0.16 gallons per square yard based on the material prior to any dilution. The acrylic resurfacer may be diluted as recommended by the manufacturer to obtain workability.

F. Wearing Coats

1. Two wearing coats shall be applied perpendicular to each other. The total amount of material to be applied shall be 0.18 to 0.30 gallons per square yard prior to any dilution. The material may be diluted as recommended by the manufacturer to obtain workability.
2. Sand shall not be added to the wearing coats.

3.3 PAINTED COURT LINES OVER COLOR SEAL COAT

A. Surface Cleaning and Preparation

1. The surface shall be cleaned of all dirt, loose sand, and stone. The Contractor shall power wash the surface clean to the satisfaction of the Engineer prior to applying the line paint over color seal coat.
2. Before application of each coat of line paint, the surface shall be blown free of all dirt and foreign matter and shall be free from standing water and oils.

B. Paint Application

1. All painted lines shall be carefully laid out as indicated on the Drawings and defined on the surface by chalk markings before being painted. Line widths and dimensions shall be as indicated on the Drawings.
2. Two (2) coats of line paint shall be applied. At least two (2) hours shall elapse between the painting of the first and second coats. All painted lines shall be accurately painted within the limits shown on the plans. Lines shall be clear and distinct with sharply defined edges.

3.4 INSPECTION:

- A. Each coat is subject to inspection. Do not apply additional coats until completed coat has been approved by the Engineer.
- B. Only inspected coats of paint will be considered in determining number of coats applied.
- C. Guarantee Inspection: At the guarantee inspection if the color seal coat is found to be peeling or fading due to improper installation the contractor shall be responsible to re-apply at his own expense.
- D. Refinish entire section where portion of finish has been damaged or is not acceptable.

3.5 TOUCH-UP PAINTING

- A. All touch up painting must be identical in color and finish to the originally prepared field-applied finish. Apply in strict accordance with paint manufacturer's recommendations and these specifications.

3.6 PROTECTION/CLEAN-UP

- A. Protect work completed until acceptance of project. Repair or touch-up color seal coat or painted game and court lines if defaced or damaged prior to acceptance.
- B. As work proceeds, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris related to this work. Repair damage to other areas as a result of painting and color seal coat operations.

**END OF SECTION**



SECTION 32 18 23.15 – CLAY INFIELD SURFACE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the contract, including General Conditions and Special Provisions, and Division One General Requirements apply to the work specified in this section.

1.2 SECTION INCLUDES

- A. Construction of clay infield surface and base course for baseball field as indicated on Drawings.

1.3 RELATED SECTIONS

- A. Section 11 68 33 - Athletic/Recreation Equipment
- B. Section 31 23 16 - Earthwork
- C. Section 32 11 23 - Processed Aggregate Base
- D. Section 32 15 41 - Stone Screenings

1.4 SUBMITTALS

- A. Product Data: Manufacturer's specifications and technical data indicating material compliance and specified options, including the following information.
  - 1. Manufacturer's recommended installation instructions.
  - 2. Maintenance literature.
  - 3. Base Course: Conform to Section 32 11 23, Item 2.1, Processed Aggregate Base.
- B. Product Samples:
  - 1. Clay Infield Surface Course: Submit one (1) quart size sample for approval.

1.5 QUALITY ASSURANCE

- A. Material Standards: As defined in State of Connecticut, Department of Transportation Standard Specifications - Form 816-2004 (DOT 816) inclusive of all supplements.

1.6 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work. Conform to Article 9.43.01 and 9.43.03, Form 816 for dust control. No claim for extra compensation will be allowed. All costs for dust control as directed by the Engineer shall be borne by the Contractor and included in the contract bid.

PART 2 PRODUCTS

2.1 COMPACTED GRAVEL BASE: Conform to Section 32 11 23 -Processed Aggregate Base.

2.2 CLAY INFIELD SURFACE

- A. Clay infield field surfacing shall be as manufactured by Keegan Bros., Wallingford, CT. Phone: (203) 484-0187.
- B. Product / Material: Material shall be Keegan Bros. "Extra Heavy Clay" incorporating a calcined clay product with the extra heavy clay. Calcined clay product shall be manufactured by "Turfus" or "Diamond Pro" or approved equal. Calcined clay shall be added and mixed by the bag rate indicated on the packaging.

2.3 CLAY BRICKS

- A. Sunmark Sports International, Troutdale, OR 97060  
Products: *Sunmark Sports Clay Bricks*  
*Diamond Pro Mound/HP Bricks*  
Phone: 888-214-7333 or 503-241-7333  
Fax: 503-491-0279  
Website: [www.sunmarksports.com](http://www.sunmarksports.com)
- B. Mar-Co Clay Products Inc., Bright, Ontario, Canada N0J1B0  
Product: *Mar-Co Field Bricks*  
Phone: 800-950-2555  
Fax: 519-684-7457  
Website: [www.marcoclay.com](http://www.marcoclay.com)
- A. Partac Peat Corporation, Kelsey Park, Great Meadows, NJ 07838  
Products: *Beam Clay Mound Bricks*  
*Mar Mound Clay Bricks*  
*Diamond Pro Mound/HP Bricks*

Phone: 800-247-BEAM  
Fax: 908-637-8421  
Website: [www.beamclay.com](http://www.beamclay.com)

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- A. Verify the subbase surface to be smooth, free of irregularities, depressions, or unsuitable material which cannot be compacted to the required density. Prepare subbase as required, conforming to Section 32 11 23 -Processed Aggregate Base, Item 3.1.

**3.2 INSTALLATION**

- A. Install gravel base true to line and grade, depth as indicated on the drawings, and compacted to the required density. Conform to Section 32 11 23 -Processed Aggregate Base.
- B. Install surface course on top of processed aggregate base course using light equipment, protecting base course from damage.
  - 1. Light blade equipment shall be used to spread and distribute surface courses.
  - 2. After spreading and blading surface course material, the top course shall be rolled with equipment of not more than 500 lbs. per square inch on bearing surface.
  - 3. Fine grade as indicated on the Grading and Drainage Plan.

**3.3 PROTECTION/CLEAN UP**

- A. Maintain proper drainage to prevent washouts and flooding of surface. Protect from damage and make repairs as required.
- B. Protect all work until acceptance of the project. Replace or refinish the clay infield surface if damaged prior to acceptance.
- C. Clean up all debris from installation procedures, including but not limited overflow of clay into/onto areas specified to be lawn or warning track surfaces.

**END OF SECTION**

SECTION 32 31 13 - CHAIN-LINK FENCE AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide and install PVC-coated chain link fencing and integral yellow-painted foul poles including cast-in-place concrete foundations using Sona-tube forms on all posts as indicated in the Drawings.

1.2 SUBMITTALS

- A. Changes in specifications may not be made after the bid date. Proposed changes must be made in writing to the Landscape Architect.
- B. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
- C. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.
- D. Samples: Color selection for PVC finishes. Samples of all fabric materials, 18" x 18" square with knuckled edges.

1.3 WARRANTY

- A. Manufacturer shall submit to the Owner written product warranties for a minimum period of 18 months from date of substantial completion of all work performed under each phase of this contract and upon acceptance of the products. The Contractor shall promptly furnish, without cost to the Owner, any and all parts and labor which prove defective in material and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Products from qualified manufacturers having a minimum of five years experience manufacturing thermally fused chain link fencing will be acceptable by the Landscape Architect as equal if they meet the following specifications for design, size gauge of metal parts and fabrication.
- B. Approved Manufacturers/Suppliers:
  - 1. Anchor Fence, Inc., Baltimore, MD

Phone (410) 633-6500 Fax (410) 633-6506

2. Atlas Fence Company, Branford, CT  
Phone (203) 483-9013 Fax (203) 483-9985
3. Ameristar "Permacoat" Chain Link Fence  
Ameristar Corporation, P.O. Box 581000, Tulsa, OK, 74158  
Phone (800) 321-8724 Fax (918) 835-0899, [www.ameristarfence.net](http://www.ameristarfence.net)

## 2.2 CHAIN LINK FENCE FABRIC

- A. PVC coating thermally fused to metallic-coated steel core wire: ASTM F 668 Class 2b, 7 mil (0.18 mm) thickness thermally fused. Core wire tensile strength 75,000 psi (517 MPa).  
- ASTM F 934.
- B. Size: Helically wound and woven to height indicated on drawings with 2" (50 mm) diamond mesh, with a core wire diameter as indicated on the Drawings and a breakload of 1290 lbs. (5740 N).
- C. Selvage of fabric knuckled both top and bottom.
- D. Color to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

## 2.3 STEEL FENCE FRAMING

- A. Steel pipe - Type I: ASTM F 1083, standard weight schedule 40; minimum yield strength of 25,000 psi; sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/ft<sup>2</sup> of coated surface area.
- B. Steel pipe - Type II: Cold formed and welded steel pipe complying with ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi (344 MPa), sizes as indicated. Protective coating per ASTM F 1043, external coating Type B, zinc with organic overcoat, 0.9 oz/ft<sup>2</sup> (275 g/m<sup>2</sup>) minimum zinc coating with chromate conversion coating and verifiable polymer film. Internal coating Type B, minimum 0.9 oz/ft<sup>2</sup> (275 g/m<sup>2</sup>) zinc or Type D, zinc pigmented, 81% nominal coating, minimum 3 mils (0.08 mm) thick.
- C. Formed steel ("C") sections: Roll formed steel shapes complying with ASTM F 1043, Group II, produced from 45,000 psi (310 MPa) yield strength steel; sizes as indicated. External coating per ASTM F 1043, Type A, minimum average 2.0 oz/ft<sup>2</sup> (610 g/m<sup>2</sup>) of zinc per ASTM A 123, or 4.0 oz/ft<sup>2</sup> (1220 g/m<sup>2</sup>) per ASTM A 525. C section post may have ASTM F 1043, Type C external and internal coating consisting of 0.9 oz/ft<sup>2</sup> (275 g/m<sup>2</sup>) zinc 5% aluminum-mischmetal alloy, per ASTM A 875.
- D. Steel square sections: [ASTM A 500, Grade B] Steel having minimum yield strength of 40,000 psi (275 MPa); sizes as indicated. Hot-dipped galvanized with minimum 1.8 oz/ft<sup>2</sup> (550 g/m<sup>2</sup>) of coated surface area.

- E. PVC-Coated finish: In accordance with ASTM F1043, apply supplemental color coating of 10 to 15 mils (0.254 - 0.38 mm) of thermally fused PVC.
- F. Terminal and Corner Posts: as indicated on the Drawing  
Line (intermediate) Posts: as indicated on the Drawings  
Rails and Braces: as indicated on the Drawings
- G. Color to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

#### 2.4 CHAIN LINK SWING GATES

- A. Gate frames: Fabricate chain link swinging gates in accordance with ASTM F 900 using galvanized steel tubular members, 2" square, weighing 2.60 lb/ft. Weld all joints to form a rigid one-piece unit. Vinyl-coated frames thermally fused with 10 to 15 mils of PVC per ASTM 1043. Gate height shall match the adjoining fence.
- B. Chain link fabric: PVC thermally fused to metallic coated steel wire, ASTM F 668, Class 2b, in color, mesh and gauge to match fence. Install fabric with hook bolts and tension bars at all 4 sides. Attach to gate frame at not more than 15" on center. Color: black.
- C. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size. Field coat moveable parts (e.g. hinges, latch, keeper, and drop bar) with PVC touch up paint, provided by manufacturer, to match adjacent finishes.
- D. Hinges: Structurally capable of supporting gate-leaf and allow opening and closing without binding. Nonlift-off type hinge design shall permit gate to swing 180 degrees as indicated on the drawings.
- E. Latch: Forked type capable of retaining gate in closed position with provision for padlock. Latch shall permit operation from either side of gate.
- F. Keeper: Provide keeper for each gate-leaf over 5' wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
- G. Double gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock eyes as an integral part of latch, requiring one padlock for locking both gate leaves.
- H. Color: Color for all frames, fabrics, hardware and all other components to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

## 2.5 ACCESSORIES

- A. Chain link fence accessories: Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing. Conform to ASTM F 626.
- B. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post. Where top rail is used, provide tops for line posts to permit passage of top rail.
- C. Top rail and brace rail ends: Formed steel, malleable or cast iron, for connection of rail and brace to terminal posts.
- D. Top rail sleeves: 6" (152 mm) sleeve allowing for expansion and contraction of top rail.
- E. Wire ties: 9 gauge [0.148" (3.76 mm)] galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge [0.092" (2.324 mm)] for rails and braces. Hog ring ties of 12-1/2 gauge [0.0985" (2.502 mm)] for attachment of fabric to tension wire.
- F. Brace and tension (stretcher bar) bands: Pressed steel.
- G. Tension (stretcher) bars: One piece lengths equal to 2 inches (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm). Provide tension (stretcher) bars where chain link fabric meets terminal posts.
- H. Truss rods: Steel rods with minimum diameter of 5/16" (7.9 mm).
- I. Nuts and bolts are galvanized but not vinyl coated. Paint nuts and bolts with touch up paint to match vinyl coating.

## 2.6 SETTING MATERIALS

- A. Concrete: Minimum 28-day compressive strength of 3,000 psi (20 MPa).

## Part 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

### 3.2 CHAIN LINK FENCE FRAMING INSTALLATION

- A. Install chain link fence in accordance with ASTM F 567 and manufacturer's instructions and as indicated in the Drawings.

- B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30 degrees or more.
- C. Space line posts uniformly at 10'-0" on center.
- D. Concrete set all posts: Drill holes in firm, undisturbed or compacted soil. Use Sona-tube forms for each post. Inside diameter of Sona-tube form shall have diameter 4 times greater than outside dimension of post. Holes shall be approximately 6" deeper than post bottom as indicated in the Drawings. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts.
- E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- F. Bracing: Install horizontal pipe brace at mid-height for fence locations indicated in the Drawings, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.
- G. Top rail: Install lengths of top rail, 21' long. Connect joints with sleeves for rigid connections for expansion/contraction.
- H. Center Rails: Install mid rails between posts with fittings and accessories as indicated in the Drawings.
- I. Bottom Rails: Install bottom rails between posts with fittings and accessories.

### 3.3 CHAIN LINK FABRIC INSTALLATION

- A. Fabric: Install fabric as indicated on the Drawings and attach so that fabric remains in tension after pulling force is released. Refer to Drawings for dimension between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" on center and to rails and braces at 24" on center.
- B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" on center.

### 3.4 ACCESSORIES

- A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.
- B. Fasteners: Install nuts on side of fence opposite fabric side for added security.

### 3.5 GATE INSTALLATION

- A. Set keeper, stops, and sleeves into concrete.



- B. Install gates plumb, level, and secure for full opening without interference.
- C. Attach hardware by means which will prevent unauthorized removal.
- D. Adjust hardware for smooth operation.

3.6 CLEANING

- A. Clean up debris and unused material, and remove from the site.

**END OF SECTION**

SECTION 32 31 13.33 - BACKSTOP

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide and install PVC-coated baseball backstop including cast-in-place concrete foundations using Sona-tube forms as indicated in the Drawings.

1.2 SUBMITTALS

- A. Changes in specification may not be made after the bid date. Proposed changes must be made in writing to the Landscape Architect.
- B. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
- C. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.
- D. Samples: Color selections for PVC finishes. Samples of all fabric materials, 18" x 18" square with knuckled edges.

1.3 WARRANTY

- A. Manufacturer shall submit to the Owner written product warranties for a minimum period of 18 months from date of substantial completion of all work performed under each phase of this contract and upon acceptance of the products. The Contractor shall promptly furnish, without cost to the Owner, any and all parts and labor which prove defective in material and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Products from qualified manufacturers having a minimum of five years experience manufacturing thermally fused chain link fencing will be acceptable by the Landscape Architect as equal if they meet the following specifications for design, size gauge of metal parts and fabrication are met.

A. Approved Manufacturers/Suppliers:

1. Anchor Fence, Inc., Baltimore, MD  
Phone (410) 633-6500 Fax (410) 633-6506

2. Atlas Fence Company, Branford, CT  
Phone (203) 483-9013 Fax (203) 483-9985
3. Boundary Fence and Railing Systems, Richmond Hill, NY  
Phone (800) 628-8928

## 2.2 CHAIN LINK FENCE FABRIC

- A. PVC coating thermally fused to metallic coated steel core wire: ASTM F 668 Class 2b, 7 mil (0.18 mm) thickness. Core wire tensile strength 75,000 psi (517 MPa). Color: Black - ASTM F 934.
- B. Size: Helically wound and woven to heights indicated on drawings.  
  
Roof fabric: 2" (50 mm) diamond mesh of 9 gauge core wire with a diameter of 0.148" (3.76 mm) and a breakload of 1290 lbs (5740 N).  
  
Side Fabric: Woven to height indicated on drawings with 2" (50 mm) diamond mesh of 6 gauge core wire with a diameter of 0.192" (4.88 mm) and a breakload of 2170 lbs (9650 N).
- C. Selvage of fabric knuckled both top and bottom.

## 2.3 STEEL FENCE FRAMING

- A. Steel pipe - Type I: ASTM F 1083, standard weight schedule 40; minimum yield strength of 25,000 psi (170 MPa); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/ft<sup>2</sup> (550 g/m<sup>2</sup>) of coated surface area.
- B. PVC-coated finish: In accordance with ASTM F1043, apply supplemental color coating of 10-15 mils (2.54 - 0.38 mm) of thermally fused PVC. Color: Black – ASTM F 934.
- C. End and Corner Post: 4" od (101.6 mm) 9.11 lbs per/ft (13.6 kg/m)  
Line (intermediate) Post: 4" od (101.6 mm) 9.11 lbs per/ft (13.6 kg/m)
- D. Horizontal rails and roof members 2" od (48 mm) 2.72 lbs per/ft (3.65 kg/m)

## 2.4 VINYL COATED ACCESSORIES

- A. Chain link fence accessories: ASTM F 626, Provide items required to complete fence system. Galvanize each ferrous metal item in accordance with ASTM A 153 and finished to match framing.
- B. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post.

- C. Top rail and brace ends: Formed steel, malleable of cast iron, for connection of rail and brace to posts.
- E. Wire ties and clips: 10 gauge [0.135" (3.43 mm)] galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge [0.092" (2.324 mm)] for rails and braces. Hog ring ties of 12-1/2 gauge [0.0985" (2.502 mm)] for attachment of fabric to tension wire.
- F. Brace and tension (stretcher bar) bands: Pressed steel. At square post provide tension bar clips.
- G. Tension (stretcher) bars: One piece lengths equal to 2" (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm) or equivalent fiberglass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
- H. Nuts and bolts are galvanized but not vinyl coated. Cans of touch up PVC paint are available to color coat nuts and bolts if desired

## 2.5 SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 psi (20 Map)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

### 3.2 CHAIN LINK FENCE FRAMING INSTALLATION

- A. Install chain link fence in accordance with ASTM F 567 and manufacturers instructions and as indicated in the Drawings.
- B. Concrete set all posts: Drill holes in firm, undisturbed or compacted soil. Use Sona-tube forms for each post. Inside diameter of Sona-tube form shall have diameter 4 times greater than outside dimension of post. Hole depth shall be as indicated in the Drawings. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom below surface, to depth indicated in the Drawings, when in firm, undisturbed soil. Place concrete around posts in a continuous pour in Sona-tube form. Trowel finish around post. Slope to direct water away from posts.
- C. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- D. Rail: Install single lengths between posts.

### 3.3 CHAIN LINK FABRIC INSTALLATION

- A. Fabric: Install fabric on field side, and attach so that fabric remains in tension after pulling force is released. Leave approximately 1" between finish grade and bottom selvage. Attach fabric with wire ties or clips to line posts at 15" on center and to rails, braces, and tension wire at 24" on center.
- B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands spaced maximum of 15" on center.

### 3.4 ACCESSORIES

- A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.
- B. Fasteners: Install nuts on side of fence opposite fabric side for added security.

### 3.5 CLEANING

- A. Clean up debris and unused material, and remove from the site.

**END OF SECTION**

SECTION 32 31 19 - METAL FENCE

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 1 – General Requirements apply.

1.2 SECTION INCLUDES

Under this Item the Contractor shall furnish and supply mortar and masonry grout in accordance with the plans, specifications and directions of the Engineer, including but not limited to:

- 1. Ornamental steel picket fencing, gates and accessories.

1.3 RELATED SECTIONS

- A. Section 03 30 01 – Portland Cement Concrete (Site)
- B. Section 31 23 16 – Unclassified Excavation

1.4 SUBMITTALS:

- A. Changes in specification may not be made after the bid date.
- B. Shop Drawings: Layout of fence with dimensions, details and finishes of component accessories and post foundations.
- C. Product Data: Manufacturer's catalogue cuts indicating material compliance and specified options.
- D. Samples: Color selections for polyester finishes. If requested, samples of materials, (e.g. finials, caps, and accessories).

1.5 WARRANTY

- A. Provide manufacturer's standard limited warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering and corroding for a period of 15 years.
- B. Manufacturer shall submit to the Owner written product warranties for the period indicated above from date of substantial completion of all work performed under each phase of this contract and upon acceptance of the products. The Contractor shall promptly furnish,

without cost to the Owner, any and all parts and labor which prove defective in material and workmanship.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

#### A. Ornamental Picket Fence

1. Master Halco, Inc. P.O. Box 365 La Habra, CA 90633; phone (800) 833-8384. Products from other qualified manufacturers having a minimum of 5 years experience manufacturing ornamental picket fencing will be acceptable by the architect as equal, if approved in writing, ten days prior to bidding, and if they meet the following specifications for design, size, gauge of metal parts and fabrication. (Note: fence is carried by a variety of distributors.)
2. Ornamental Picket Fence:
  - a. Style: Imperial
  - b. Heights: 72 inches (1829 mm).
  - c. Color: Color to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

### 2.2 ORNAMENTAL PICKET FENCE

- A. Pickets: Steel square tubular members having a 25,000 psi (172 Mpa) yield strength.
  1. Minimum size pickets 3/4 inch (19 mm).
  2. Minimum gauge wall thickness 16 gauge.
  3. Space pickets 3-15/16 inches maximum (100 mm) face to face.
  4. Attach each picket to each rail with #6 stainless steel screws or pop rivets.
- B. Rails: 1-1/2" (38mm) x 1" (25mm) x 1-1/2" (38mm), aluminum "U" channel having a 35,000 psi (241 MPa) yield strength.
  1. Punch rails to receive pickets, screws and or rivets.
  2. Attach rails to rail brackets with 2 each, 1/4 inch (6 mm) bolt w/ lock-nut.
- C. Posts: Steel square tubular members (with interior offset bracing) having a 35,000 psi (241 MPa) yield strength.
  1. Post Size B (60 inch high fence): 2 1/2 inches (135 mm), having 14 gauge wall thickness [0.080 inch (2.03 mm)], weighing 2.733 lb/ft (4.07 kg/m).
- D. Accessories: Assembled panels with ornamental accessories attached using industrial drive rivets to prevent removal and vandalism.

- E. Finish: All pickets, channels, posts, fittings and accessories shall be polyester coated individually after punching, drilling and layout, to ensure maximum corrosion protection. (Coating of assembled sections is unacceptable).
1. All components shall be given a four (4) stage "Power Wash" pre-treatment process that cleans and prepares the galvanized surface to assure complete adhesion of the finish coat.
  2. All metal shall then be given a polyester resin based power coating applied by the electrostatic spray process, to a thickness 2.5 (.0635 mm) mils. The finish shall then be baked in an oven at 450 degrees F (232 degrees C) (metal temperature) for 20 minutes.
  3. Color: Color to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

### 2.3 ORNAMENTAL PICKET SWING GATES

- A. Gate Frames: Fabricate ornamental picket swing gate using galvanized steel members, ASTM A78, structural quality steel, 45,000 psi (310 MPa) tensile strength, with galvanized G90 coating. Frame members welded using stainless steel welded to form rigid one-piece unit. (no substitution) Minimum size vertical uprights, 2"(50 mm) square 13 gauge [0.095" (2.324 mm)] wall thickness.
- B. Ornamental Picket Infill: "U" channel rails, formed from hot rolled, structural steel, 1-3/8" (35 mm) wide x 1-1/2" (38 mm) deep, 11 gauge [0.120" (3.05 mm)] wall thickness. Punch rails to receive pickets, and weld inside gate frame. Pickets, galvanized steel, [3/4" (19 mm)] [1" (25 mm)] square tube [of gauge, spacing, and with accessories to match fence]. Attach pickets to "U" rails by 1/4" industrial drive rivets, size #4.
- C. Bracing: Provide diagonal adjustable length truss rods on gates to prevent sag.
- D. Hardware Materials: Galvanized steel or malleable iron shapes to suit gate size.
- E. Hinges: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180° (3.14 rad).
- F. Latch: Capable of retaining gate in closed position and have provision for padlock.
- G. Door and gate hardware, including handles, pulls, latches, locks and other operating devices on accessible doors shall have a shape that is easy to grasp with one hand and does not require tight grasping, thigh pinching, or twisting of the wrist to operate. Lever-operated mechanisms, push-type mechanisms, and u-shaped handles are acceptable designs. Mount no hardware required for accessible door passage higher than 48 inches above finished floor (grade).



- H. Keeper: Provide keeper for each gate leaf over 5' (1500 mm) wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
- I. Double Gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock eyes as an integral part of latch, requiring one padlock for locking both gate leaves.
- J. Gate Posts: Square members, ASTM A787, structural quality steel 45,000 psi (310 MPa) tensile strength, with galvanized G90 coating; size as indicated below:

<u>Gate Leaf Single Width</u>	<u>Post Size (square)</u>	<u>Weight</u>
3 ft (914 mm) to 4 ft (1219 mm) (6.38kg/m)	3" (76 mm)	4.286lb/fn
4 ft (1219 mm) to 8 ft (2438 mm) (8.59kg/m)	4" (101.6 mm)	5.770lb/ft

- K. Polyester Powder Coat Finish: After components have been galvanized to provide maximum corrosion resistance, pretreat, clean, and prepare galvanized surface to assure complete adhesion of finish coat. Apply 2.5 mil (0.0635 mm) thickness of polyester resin based powder coating by electrostatic spray process. Bake finish for 20 minutes at 450° F (232° C), metal temperature.
1. Color: Color to be determined by the architect based on selection from the full range of available colors supplied by the manufacturer. The manufacturer shall submit a color selection chart to the architect for selection.

#### 2.4 ORNAMENTAL PICKET FENCE ACCESSORIES

- A. Rail attachment with bolt-through brackets
- B. Ornamental Picket Fence Accessories: Provide indicated items required to complete fence system.
- C. Post Caps: Formed steel, cast of malleable iron or aluminum alloy, weather-tight closure cap. Provide one post cap for each post.
- D. Post Cap Style: Flat
- E. Picket Top Style: Imperial top (pickets terminate inside of rail).

#### 2.5 ORNAMENTAL PICKET FENCE SETTING MATERIAL

- A. Concrete: Minimum 28 day compressive strength of 3000 psi (20 MPa).

- B. Flanged Posts: Provide flange type base plates with 4 holes for surface mounting of posts where indicated.

### PART 3 EXECUTION

#### 3.0 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

#### 3.1 INSTALLATION

##### A. Ornamental Picket Fence

1. Install fence in accordance with manufacturer's instructions.
2. Space posts uniformly at 7' 8-3/4" maximum face to face unless otherwise indicated.
3. Concrete set gate posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post, and depth approximately 6" deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" below surface when in firm, undisturbed soil. Place concrete around posts in continuous pour. Trowel finish around post and slope to direct water away from posts.
  - a. Gate posts and hardware: Set keepers, stops, sleeves into concrete. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
4. Check each post for vertical and top alignment, and maintain during placement and finishing operation.
5. Align fence panels between posts. Firmly attach rail brackets to posts with 1/2" bolt and lock nut, ensuring panels and posts remain plumb.

#### 3.2 GATE INSTALLATION

##### A. Ornamental Picket Fence

1. Install gates plumb, level, and secure for full opening without interference.

2. Attach hardware by means which will prevent unauthorized removal.
3. Adjust hardware for smooth operation.

2.3 ACCESSORIES

- A. Install post caps and other accessories to complete fence.

2.4 CLEANING

- A. Clean up debris and unused material, remove from site.

END OF SECTION

SECTION 32 32 23 - MODULAR RETAINING WALL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Conditions and Special Conditions.

1.2 SUMMARY

- A. This work shall consist of the furnishing and construction of a Modular Retaining Wall System in accordance with these specifications and in reasonably close conformity with the lines, grades, design, and dimensions shown on the Plans.
- B. Construction drawings and design calculations for the retaining wall system shall be prepared by a registered Professional Engineer, licensed in the State of Connecticut, and shall bear his signature and seal. The Contractor shall submit the construction drawings and design calculations to the Engineer for approval prior to beginning construction.

1.3 SUBMITTALS

- A. Contractor shall submit a Manufacturer's certification, prior to start of work, that the retaining wall system components meet the requirements of this specification.
  - 1. The contractor's submittal package shall include but not limited to actual test results for tension/creep, durability/aging, construction damage, geogrid/facing connection, pullout, and quality control.
- B. Contractor shall submit certification, prior to start of work, that the retaining wall system (modular concrete units and geogrid):
  - 1. Has been successfully utilized on a minimum of five (5) similar projects, i.e., height, soil fill types, erection tolerances, etc.; and
  - 2. Has been successfully installed on a minimum of 1 million (1,000,000) square feet of retaining walls.
- C. Contractor shall submit a list of previous projects totaling of 500,000 square feet or more where the specific retaining wall system has been used successfully. Contact names and telephone numbers shall be listed for each project.

- D. Contractor shall submit a test report documenting strength of specific modular concrete unit and geogrid reinforcement connection. The maximum design tensile load of the geogrid shall be equal to the laboratory tested ultimate strength of geogrid / facing unit connection at a maximum normal force limited by the "Hinge Height" of the structure divided by a safety factor of 1.5. The connection strength evaluation shall be performed in accordance with NCMA test method SRWU-1.
- E. Contractor shall submit engineering plans prepared by a Professional Engineer experienced with Mechanically Stabilized Earth retaining wall systems and registered in the State of Connecticut. The engineering designs, techniques, and material evaluations shall be in accordance with NCMA Design Guidelines For Segmental Retaining Walls, 1993 or the AASHTO Standard Specifications for Highway Bridges, Section 5.8, 1993 Interim, whichever is applicable.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS AND PRODUCT SYSTEM ALTERNATES

- A. Preferred manufacturer:
  - 1. TECHO-BLOC Retaining Wall Units as manufactured by TECHO-BLOC, St-Hubert, Quebec, Phone: 800-463-0450 and distributed by:
    - a) Earth Materials LLC, Orange, CT. Phone: 203-799-2322.
    - b) New England Silica, Inc., South Windsor, CT. Phone: 860-289-7778.
    - c) Washington Concrete Products Inc., Plainville, CT. Phone: 860-747-5242.
- B. Alternate manufacturers:
  - 1. Versa-Lok Retaining Wall Systems, Oakdale, MN 55128, Phone: 800-770-4525 or 651-770-3166, Fax: 651-770-4089. Distributed by Versa-Lok Retaining Wall Systems, PO Box 6002, Nashua, NH 03063, Phone: 603-883-3042, Fax: 603-598-8227.
  - 2. Anchor Retaining Wall Systems, Minnetonka, MN 55345-5996, Phone: 877-295-5415. Distributed by Grinnell, Engineered Walls Division, Sparta, NJ 07871, Phone: 973-383-9300, Fax: 973-383-3224.
- C. Note: Phone numbers are provided here for the Contractors convenience. Due to the continually changing phone market, Contractor is responsible for verifying the accuracy of the phone numbers listed.

- D. The TECHO-BLOC Retaining Wall materials identified below and chosen for the design of the modular retaining wall system have been specifically referred to so as to enable the Owner to establish the level of quality and performance required by the modular retaining wall system design. Materials by other acceptable manufacturers listed above shall meet or exceed materials chosen for the design of the modular retaining wall system.

## 2.2 MODULAR CONCRETE RETAINING WALL UNITS

- A. Preferred Modular Units: TECHO-BLOC “QUARRY-STONE” Retaining Wall Units as manufactured by TECHO-BLOC, St-Hubert, Quebec.

1. Color: Honey Brown / Mojave Beige
2. Modular Unit Nominal Dimensions:
  - a) 4" x 9" x 8"
  - b) 4" x 9" x 12"
  - c) 4" x 9" x 15.75"
  - d) 4" x 9" x 19.68"
  - e) 8" x 9" x 8"
  - f) 8" x 9" x 12"
  - g) 8" x 9" x 15.75"
  - h) 3" x 12" x 9" (cap)
  - i) 3" x 12" x 12" (cap)
  - j) 3" x 12" x 15" (cap)

- B. Alternate Modular Units: “MOSAIC – WEATHERED SERIES” Retaining Wall Units as manufactured by Versa-Lok Retaining Wall Systems, Oakdale, MN 55128.

1. Color: To be selected by Landscape Architect from standard colors.
2. Modular Unit Nominal Dimensions:
  - a) 6" x 16" x 12" (standard)
  - b) 4" x 12" x 12" (accent)
  - c) 6" x 8" x 12" (cobble)
  - e) 3" x 14" x 12" (cap)

- C. Alternate Modular Units: “ANCHOR HIGHLAND STONE” Retaining Wall Units as manufactured by Anchor Retaining Wall Systems, Minnetonka, MN 55345-5996 as distributed by Grinnell, Engineered Walls Division, Sparta, NJ 07871

1. Color: To be selected by Landscape Architect from standard colors.
2. Modular Unit Nominal Dimensions:

- a) 6" x 6" x 12" (small)
- b) 6" x 12" x 12" (medium)
- c) 6" x 18" x 12" (large)
- d) 12" x 6" x 13.25" (jumper)
- e) 3" x 17.25" x 10" (cap)

**D. Requirements**

1. Modular units shall be machine formed, Portland Cement concrete blocks specifically designed for retaining wall applications. Concrete used to manufacture modular units shall have a minimum 28 day compressive strength of 3,000 psi and a maximum moisture absorption rate, by weight, of 8% as determined in accordance with ASTM C1372.
2. Modular units shall be solid concrete through the full depth of the unit.
3. Modular units shall be capable of providing a textured surface face for all vertical surfaces that will be exposed after completion of wall, including any exposed sides and backs of units
  - a. Face Finish - sculptured rock face in angular multiplaner configuration. Other face finishes will not be allowed without written approval of Owner.
  - b. Bond Configuration - running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
  - c. Exposed Surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused lighting.
4. Modular units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the structure. Cracking or excessive chipping may be grounds for rejection. Units showing cracks longer than 2@ shall not be used within the wall.
5. Modular units shall be interlocked with inserts supplied by the manufacturer. Wall inserts shall be installed so as to provide the modular wall with a stepped face.
6. Modular units shall be capable of being erected with the horizontal gap between adjacent units not exceeding 1/8 inch.
7. Modular units shall be capable of providing overlap of units on each successive course so that walls meeting at corner are interlocked and continuous. Modular units that required corners to be mitered shall not be allowed.

8. Modular units molded dimensions shall not differ more than +/- 1/8 inch from that specified, in accordance with ASTM C1372.
- E. Material Requirements: See Section 02751 - Portland Cement Concrete Pavement and Curbing.
- F. Structural and Geometric Requirements:
1. Compressive strength = 3,000 psi minimum
  2. Absorption = 8% maximum (6% in northern states) for standard weight aggregates
  3. Unit depth - 20 inches minimum
  4. Unit width to height ratio = 2.25:1
  5. Unit weight - 90 lbs/unit minimum for standard weight aggregates
  6. Inter-unit shear strength - 1500 plf minimum at 2 psi normal pressure
  7. Geogrid/unit peak connection strength - 1000 plf minimum at 2 psi normal force
  8. Maximum horizontal gap between erected units shall be - 2 inch

### 2.3 BASE LEVELING PAD MATERIAL

- A. Material shall consist of a compacted gravel base as shown on the construction drawings and conforming to Section 02680 - Processed Aggregate Base. The leveling pad shall be a minimum of 6 inches thick.

### 2.4 DRAINAGE AGGREGATE

- A. Drainage aggregate shall consist of clean 1@ minus crushed stone or crushed gravel meeting the gradation listed below:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	75-100
No. 4	0 - 10
No. 50	0 - 5



- B. One cubic foot, minimum, of drainage aggregate shall be used for each square foot of wall face. Drainage aggregate shall be placed within cores of, between, and behind units to meet this requirement.

2.5 REINFORCED BACKFILL

- A. Reinforced backfill shall be free of debris and meet the following gradation requirements:

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inch	100-75
3/4 inch	100-75
No. 4	100-20
No. 40	0-60
No. 200	0-35

Plasticity Index (PI) <10 and liquid limit <40.

- B. The maximum aggregate size shall be limited to 3/4 inch unless field tests have been or will be performed to evaluate potential strength reductions to the geogrid design due to damage during construction.
- C. Material can be site excavated soils where the above requirements can be met. Unsuitable material for backfill shall not be used as backfill or in the reinforced soil mass.
- D. Contractor shall submit reinforced fill sample and laboratory test results to the Engineer for approval prior to the use of any proposed reinforced fill material.

2.6 GEOGRID

- A. Allowable Tensile Design Load,  $T_a$ , shall be determined as follows:

1.  $T_a = T_{cr}/(FD*FC*FS)$
2.  $T_a$  shall be evaluated based on a 75 year design life.

- B. Creep Limited Tensile Load,  $T_{cr}$

1.  $T_{cr}$  shall be determined from 10,000 hour creep testing performed in accordance with ASTM D5262.

- C. Factor for Durability/Aging,  $FD$

1.  $FD$  shall be determined from polymer specific durability testing covering the range of expected soil environments.

- D. Factor for Construction Damage,  $FC$

1. FC shall be determined from product specific construction damage testing performed in accordance with GRI-GG4. Test results shall be provided for each product to be used with project specific or more severe soil type.
- E. Overall Factor of Safety, FS
  1. FS shall be 1.5 unless otherwise noted.
- F. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection as limited by the  $\frac{Hinge\ Height}{1.5}$  divided by a factor of safety of 1.5. The connection strength testing and computation procedures shall be in accordance with NCMA test methods.
- G. Soil Interaction Coefficient, Ci
  1. Ci values shall be determined per GRI:GG5 at a maximum 0.75 inch displacement.
- H. Manufacturing Quality Control: The geogrid manufacturer shall have a manufacturing quality control program that includes QC testing for each 40,000 SF of production, each lot, or each production day. The QC testing shall include:
  1. Tensile Modulus
  2. Specific Gravity
  3. Melt Flow Index (PP&HDPE)
  4. Molecular Weight (PETP)

### PART 3 - EXECUTION

#### 3.1 EXCAVATION

- A. Contractor shall excavate to the lines and grades shown on the Drawings. Engineer will inspect the excavation and approve prior to placement of leveling material or fill soils.
- B. Over-excavation of unsuitable material and replacement with suitable material will be paid for at the Contractor's Unit Bid Price for "Additional Unsuitable Excavation". See Section 02310 - Unclassified Excavation.

#### 3.2 BASE LEVELING PAD

- A. Leveling pad stone base material shall be placed to the lines and grades shown on the Drawings, to a minimum thickness of 6 inches.
- B. Subgrade material shall be compacted to a minimum of 95 % standard or 90 % modified Proctor.

- C. Leveling pad shall be prepared to insure full contact to the base surface of the concrete units.

### 3.3 UNIT INSTALLATION

- A. First course of units shall be placed on the leveling pad, and alignment and level checked. Pins or molded surfaces of modular concrete units shall be used for alignment control.
- B. Position vertically adjacent modular concrete units as recommended by the Manufacturer.
- C. Maximum stacked vertical height of wall units, prior to wall drain fill and backfill placement and compaction, shall not exceed two courses.
- D. Whole, or cut, units on curves and corners shall be erected with running bond approximately centered on units above and below.
- E. Cap units shall be glued to underlying units with an adhesive recommended by the manufacturer.

### 3.4 STRUCTURAL GEOGRID INSTALLATION

- A. Geogrid shall be oriented with the highest strength axis perpendicular to the wall alignment.
- B. Geogrid reinforcement shall be placed at the elevations and to the extent shown on the Drawings or as directed by the Engineer.
- C. The geogrid shall be laid horizontally on compacted backfill. Place the next course of modular concrete units over geogrid. The geogrid shall be pulled taut, and anchored prior to backfill placement on the geogrid.
- D. Geogrid reinforcements shall be continuous throughout their embedment lengths. Spliced connections between shorter pieces of geogrid is not allowed.

### 3.5 REINFORCED BACKFILL PLACEMENT

- A. Reinforced backfill shall be placed, spread, and compacted in such a manner that minimizes the development of slack in the geogrid.
- B. Reinforced backfill shall be placed and compacted in lifts not to exceed 8 inches where hand compaction is used, or 12 inches where heavy compaction equipment is used.

- C. Reinforced backfill shall be compacted to 95 % of the maximum density as determined by ASTM D695. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within 2 percentage points dry of optimum.
- D. Only lightweight hand-operated equipment shall be allowed within 3 feet from the tail of the modular concrete unit.
- E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH. Sudden braking and sharp turning shall be avoided.
- G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

**END OF SECTION**

SECTION 32 80 00 - IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. The work to be done under this contract includes but is not limited to the following:
  - 1. Furnish and install new piping, fittings, isolation valves and necessary pipe line appurtenances including the backflow assembly and a booster pump assembly.
  - 2. Furnish and install new electric control valve assemblies, sprinklers and swing joint assemblies.
  - 3. Furnish and install irrigation controllers including all necessary electrical connections with rain sensor and bypass.
  - 4. Provide one fall winterization of the system and one spring start-up.
  - 5. The Plumbing Contractor shall provide and install a water supply line and gate valve to the pump house. He shall install the backflow preventer assembly, the booster pump, and associated gate valves and piping in the pump house. And provide water service from the pump house to five (5) feet outside the pump house building as indicated on the Drawings for water service to the Irrigation System.
  - 6. The Irrigation Contractor shall attach to the water supply line outside the pump house, attach to the controller power, and run the control wires thru the building conduit.
  - 7. The Electrical Contractor shall provide and install electrical sleeving & conduit, and power service to the controller for the Irrigation System.
  - 8. The Irrigation Contractor shall coordinate his work with the plumbing and electrical Contractors.
- B. The work indicated on the site irrigation plan, details and these specifications consists of the provisions of labor, material, equipment and services required to complete all work described herein.

- C. Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper installation and completion of the work whether each necessary item is mentioned herein or not.
- D. The plans and specifications are intended to be cooperative, and any item called for in one and not the other shall be as binding as if called for in both. If a discrepancy exists between an item called for in the plans and the specifications, or within the plans or specifications, the most stringent shall apply.
- E. All work herein specified or called for on the drawings will be executed in accordance with all governing ordinances, laws and regulations that meet all local conditions. Additionally, any changes and/or additions in the work necessary to meet these ordinances, laws, regulations and/or conditions will be made without additional cost to the Owner.

### 1.3 SITE INSPECTION

- A. Each bidder shall visit the site of the proposed work and fully acquaint himself with the conditions there relating to construction and labor, and should fully inform himself as to the facilities involved, and the difficulties and restrictions attending the performance of the Contract. The Bidder should thoroughly examine and familiarize himself with Drawings, Technical Specifications and all other Bid and Contract Documents. The Contractor, by the execution of the Contract, shall in no way be relieved of any obligation under it due to his failure to receive or examine any form or legal document or to visit the site and acquaint himself with the conditions there existing and the Owner will be justified in rejecting any claim thereof.

### 1.4 AS-BUILT DRAWINGS

- A. After completion of the piping installation, the Contractor shall furnish an "as-built" drawing showing all sprinkler heads, valves, drains and pipelines to scale with dimensions where required. Instruction sheets and parts lists covering all operating equipment will be bound into a folder and furnished to the Owner in duplicate.

### 1.5 INSTRUCTIONS

- A. After completion and testing of the system, the Contractor will instruct the Owner's personnel in the proper operations and maintenance of the system.

### 1.6 GUARANTEE / WARRANTY

- A. For a period of 18 months from date of substantial completion of all work performed under each phase of this contract, the Contractor shall promptly furnish, without cost to the Owner, any and all parts and labor which prove defective in material and workmanship. In the Fall following the installation, the Contractor shall winterize the

system and the following Spring shall put the system back into operations. Winter damages due to improper winterization is the responsibility of the Contractor for the first 18 months.

- B. All sprinklers and fixed spray heads installed as part of this project shall have a manufacturer's 100-percent warranty for 5 years against defects in workmanship from date of substantial completion of all work performed under each phase of this contract. The Contractor shall promptly furnish, without cost to the Owner, any and all parts and labor to replace components that are defective in material and workmanship.

#### 1.7 SUBMITTALS

- A. The Contractor shall submit the following samples, certifications or test results prior to use on the project.
  - 1. Shop Drawings: Indicate piping layout to water source, location of sleeves under pavement, location and coverage of sprinkler heads, plant and landscaping features, site structures, schedule of fittings to be used.
  - 2. Product Data: Provide component and control system and wiring diagrams.

#### 1.8 OPERATION AND MAINTENANCE DATA

- A. Provide instructions for operation and maintenance of system and controls, seasonal activation and shutdown and manufacturer's parts catalog.
- B. Provide schedule indicating length of time each valve is required to be open to provide a determined amount of water.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS AND PRODUCT SYSTEM SUBSTITUTIONS

- A. Acceptable manufacturers:
  - 1. The Toro Company - Irrigation Division, Riverside, CA
  - 2. Hunter Industries Inc., San Marcos, CA
  - 3. Rain Bird Corporation, Azusa, CA
- B. The Toro Company irrigation materials chosen for the design of the sprinkler system have been specifically referred to so as to enable the Owner to establish the level of quality and performance required by the system design. Equipment by other acceptable manufacturers listed above shall meet or exceed materials chosen for the design of the sprinkler system.
- C. Equipment by other manufacturers not listed shall meet or exceed materials chosen for the design of the sprinkler system **and may be considered only after written**



application, at least seven (7) days prior to bid opening, including five (5) copies of specifications, is made by the Bidder and written approval is received from the Owner.

All bidders will be notified by the Owner or Engineer in writing of the approved "or equal" irrigation system.

- D. Any approved equals shall be by complete system only. Individual system component substitutions will not be approved.

## 2.2 MATERIALS

### A. LARGE GEAR DRIVEN ROTARY SPRINKLER

1. The gear driven rotary sprinkler head shall be Toro model 640-02 series and designed for inground installation. The sprinkler shall be capable of covering a 47 foot to 65 foot radius depending on the exact size of the nozzle. The Sprinkler shall use 6.0 to 25.0 gallons per minute of water at 40 to 90 pounds per square inch of pressure.
2. Water distribution shall be via two nozzles mounted in a 1-1/2 inch diameter stainless steel nozzle turret. The nozzles shall be locked in the gear drive with a set screw inaccessible to vandals. The nozzle assembly shall elevate 2-3/8 inches when in operation and retraction shall be achieved by a stainless steel spring. A nozzle wiper seal shall be included in the sprinkler for continuous operation under the presence of sand and other foreign material.
3. Coverage shall be full or part circle. The part circle coverage shall be available in standard arcs of 90, 180, and 270 degrees and special arcs of 45, 60, 108, 127, 148, 173, 192, and 238 degrees. Rotation shall be accomplished by a sealed oil-packed gear assembly, with brass drive and bull gears, and totally isolated from the water supply. The thickness of the stainless steel drive assembly shall be no less than .024 inches.
4. The body of the sprinkler shall be constructed of non-corrosive high impact Cylolac plastic with a thickness of no less than .2 inch. An integral check valve for the control of 15 feet of elevation change shall also be included. All sprinkler parts shall be removable through the top of the unit through the removal of a heavy duty 7 thread cap with a locking set screw inaccessible to vandals on the side of the cap into the body. The sprinkler shall have a 1 inch I.P.S. water connection on the bottom of the sprinkler.
5. The coverage of the sprinkler shall have a coefficient of uniformity of 91 and an R factor of 2.1.
6. The sprinkler shall be manufactured by the Toro Company, Irrigation Division, Riverside, California.

**B. MEDIUM GEAR DRIVEN ROTARY SPRINKLER**

1. Gear driven rotary sprinkler shall use .5 - 10 gpm at 30 - 70 psi with the recommended operating pressure at 50 psi.
2. All adjustments can be made from the top of the sprinkler. The top arc indication for adjustments from 90 to 360 degree.
3. Radius reduction shall be adjustable up to 25% by means of a radius reduction set screw on the top of the nozzle.
4. Nozzle height is 5" when in operation. Retraction shall be achieved by a stainless steel spring. The nozzle shall be smooth, plastic with an over-molded riser wiper seal shall prevent the sprinkler from having foreign materials enter the body. The top shall have a rubber cover.
5. The arc shall be either full circle or adjustable part circle adjustable from 0 to 360 degrees. The body shall be constructed of non-corrosive heavy duty Cycloc plastic with a basket filter screen at the base. The top shall have a dry mode pull up slot. A continuous unidirectional rotation provides uniform coverage when set at 360 degrees. Available with a standard reversible rubber check valve.
6. Body inlet shall be 3/4" IPS.
7. Each sprinkler shall have a color coded nozzle "tree" with 8 interchangeable nozzles.
8. Sprinkler trajectory is 26 degrees.
9. The gear drive shall be planetary design. The head shall have a "Smart Arc" memory that returns the sprinkler to previously set arc if the head is vandalized. A slip clutch assures no damage to the gears if vandalized.
10. The sprinkler shall be a Super 800 series as manufactured by The Toro Company, Riverside, CA.

**C. FIXED SPRAY HEAD**

1. Capable of covering up to a 17 foot radius. Depending on the exact type of nozzle, the sprinkler shall use .05 to 4.58 gpm up to 50 psi.
2. Nozzle shall be comprised of (1) or more orifices at (2) radius ranges and shall be adjustable from full-on to operation.
3. Retraction shall be achieved by a heavy duty stainless steel riser in a resilient guide with riser wiper shall be included for continuous operation under the presence of foreign material.

4. Coverage shall be either full or part circle. The part circle coverage shall be available in arcs of 90, 120, 180, 240, 270, and 360 degrees or adjustable part circle. Also included shall be special patterns including an end strip and center strip nozzle configuration. - Nozzle delivery shall be such as to allow part circle patterns to match full circle patterns in precipitation rates. Also available with effluent cap.
5. The body of the spray head shall be constructed on non-corrosive heavy duty Cynolac plastic. A filter screen shall be included in the nozzle piston
6. Patented in riser pressure regulated. Patented "X-Flow" high flow shut off device.
7. Zero flush seal prevents flushing on pop up. Also has retraction flushing for clearing debris.
8. Available body style: 2", 3", 4" 6", 6" side inlet, 12" side inlet. Available with check valve and pressure compensating devices or MPR nozzles.
9. The spray head shall be a 570 PRX series as manufactured by The Toro Company, Riverside, CA.

**D. PLASTIC CONTROL VALVE**

1. The plastic valve shall be manufactured from 33% glass filled nylon (GFN) and stainless steel with a wall thickness capable of withstanding pressures up to 220 psi and flows from 5 to 300 gpm.
2. Globe/angle configuration with FPT inlet and outlet. 1", 1 1/2", 2", and 3" sizes. Also available in BSP threads. The 2" and 3" models shall have a brass stem.
3. The diaphragm shall be made of reinforced rubber and accessible from the top of the valve, without having to remove the body. Burst pressure is 750 psi.
4. Pressure regulating unit: Precise pressure control option with compact *EZReg* dial design technology. Pressure regulates in electric and manual modes and is serviceable under pressure. Minimum pressure differential is 10 psi.
5. Built in Schrader type valve for downstream pressure verification.
6. No external tubing for either the electric or pressure regulating models. Internal downstream manual bleed and an external manual bleed feature.
7. Manual flow control is adjustable to zero flow. Check manufacturer's catalog for friction loss.
8. The electric solenoid shall be a 24 VAC type, with an inrush current of .400 amps and a holding current of .2 amps. The solenoid shall have 18" lead wires,

wired in parallel. A purple solenoid is available for effluent water. Valve can also fit a latching solenoid.

9. The plastic control valve shall be a P-220 series as manufactured by The Toro Company, Riverside, CA.

**E. QUICK COUPLER VALVE**

1. The quick coupler valve shall be Toro model 470 series, one piece single lug type.
2. The valve shall be constructed of brass with a wall thickness guaranteed to withstand a normal working pressure of 150 psi without leakage. The quick coupler valve shall accept a Toro model 460 series quick coupler key with a top connection of female pipe thread and male pipe thread.
3. The quick coupler valve shall be manufactured by the Toro Company, Irrigation Division, Riverside, California.

**F. AUTOMATIC CONTROLLER**

1. The controller shall be a Custom Command, 24 station in a plastic cabinet. 4 independent programs offer concurrent operation capability. 7-day calendar, odd/even day or day interval options of 1-30 days. Excluded day option, when used with the odd/even day option, allows selection of specific day(s) not to water.
2. 365-day clock/calendar with excluded day option.
3. Station run times of 1 minute to 10 hours in 1 minute increments. 16 total start times. Start time stacking within each program.
4. Season adjust setting from 10 to 200% in 10% increments. Rain delay up to 7 days.
5. Programmable master valve on/off per program.
6. Automatic, semi-automatic, manual, and timed manual operation. Wiring. User friendly, 10 position programming dial and large, easy-to-read LCD.
7. Snap out design allows easy removal of control module without disturbing valve.
8. Self-diagnostic circuit breaker identifies and overrides an electrical malfunction of a valve.
9. Non volatile memory retains program data through a power loss. Battery backup for up to 90 days during power loss. Lightning Surge Pro System on 24 VAC and station outputs.

10. Sensor hookups.
11. Weather resistant metal, locking cabinet with heavy duty internal transformer. Dimensions- 9 3/4" H x 10 3/4" W x 5 3/4" D. UL and CUL listed.
12. Maximum output per station is 24 VAC, .5 amps. Max. output to valves is 24 VAC, 1.25 amps. Station capacity- up to 2 24 VAC, .25 amp solenoids per station, plus master valve.
13. The automatic controller shall as manufactured by The Toro Company, Irrigation Division, Riverside, CA.

**G. RAIN GAUGE**

1. The rain gauge device shall be designed to prevent sprinkler operation during rainfall. The rain gauge shall install easily to roof eaves or 3/4 inch PVC pipe. Two wire nuts and wood screws shall be provided. The rain gauge shall be easily wired into any new or existing sprinkler control system.
2. When exposed to rain water, a stack of absorbent disks within the rain gauge shall expand and open a microswitch, interrupting power to the control valves. An adjustment knob on the rain gauge shall allow the shut-off point set from 1/8 inch to 1 inch of rainfall. The initial setting for the shut-off point shall be 1/8 inch. When the rain stops, the disks dry out allowing the microswitch to close and the sprinklers to operate as scheduled. The normally open/normally closed microswitch shall be rated 125 VAC, 4 amp. The rain gauge shall be U.L. listed.
3. The rain gauge shall be a 850-74 as manufactured by The Toro Company, Irrigation Division, Riverside, California.

**H. FEBCO 825Y - BACKFLOW PREVENTER ASSEMBLY**

1. The backflow preventer shall be model FEB825Y-020, as manufactured by Febco Sales, Fresno, California.
2. The backflow preventer assembly shall be the model 825Y Reduced Pressure Device indicated above, consisting of two independently operating, spring loaded, "Y" pattern check valves and one hydraulically dependent differential relief valve. The device shall automatically reduce the pressure in the "zone" between the check valves to at least 5 psi lower than the inlet pressure. Should the differential between the upstream and the zone of the unit drop to 2 psi, the differential relief valve shall open and maintain the proper differential.
3. Mainline valve body and caps, including relief valve body and cover, shall be bronze. Check valve moving member shall be center stem guided. All hydraulic sensing passages shall be internally located within the mainline and relief valve bodies and relief valve cover. Check valve and relief valve components shall be constructed so they may be serviced without removing the valve body from the line. Shut-off valves shall be fully ported.

4. The device shall be rated to 175 psi water working pressure and water temperature range from 32 degrees F to 140 degrees F.

**I. BOOSTER PUMP ASSEMBLY**

1. The pump shall be as manufactured by Sta Rite Industries, Delavan, WI. The relay shall be as manufactured by Batrow, Stratford, CT.
2. The booster pump assembly shall be JB series, Model No. JBMMG. The booster pump assembly shall be individually mounted. The pump shall be a closed coupled centrifugal type, designed specifically for booster service.
3. The pump shall be capable of 65 gpm minimum at a 20 to 50 psi boost. The motor shall be 230 Volt Single Phase. Motor horsepower shall be 2.5 HP. The pump start shall either be from a relay or from the Irrigation Controller.
4. The unit shall include pump protection from a "Hot Stop" Pump Protection unit. Also include a pressure gauge and a line sized check valve.

**J. VALVE ACCESS BOX**

1. Valve boxes shall be constructed of a rigid combination of polyolefin and fibrous components especially compounded for underground enclosures. Superflexion plastic material shall be chemically inert and normally unaffected by moisture, corrosion and the effects of temperature changes. Superflexion shall also have a relatively high tensile strength with light weight because of its solid structural material.
2. Valve boxes shall be available in the following configurations: Round - 10 inches x 13 inches x 10 1/4 inches deep; Standard - top: 10 3/4 inches x 16 inches, bottom: 10 3/4 inches x 18 1/2 inches and 12 inches deep; Jumbo - top: 14 3/4 inches x 21 1/2 inches, bottom: 17 1/4 inches x 24 inches and 12 inches deep.
3. The contractor shall fill the entire area beneath the box with pea gravel before final installation of each box.
4. The valve box shall be model BKS1419-12WC and NDS-212BC as manufactured by Brooks Industries, Flora, MS.

**K. POLY-VINYL CHLORIDE (PVC) PIPE**

1. All PVC pipe specified on the plan shall be virgin, high impact, poly-vinyl chloride (PVC) pipe, having a minimum working pressure rating of Class 200 for 1-1/2 inches and larger or Class 200 for pipe which is 1-1/4 inches and smaller in size.

2. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, material, size and schedule or type. The pipe shall be capable of withstanding a long term pressure test (1,000 hours) of 420 psi and a quick term burst test of 630 psi.
3. The pipe shall conform to U.S. Department of Commerce Commercial Standard CS 207-60, or latest revision. Material shall conform to all requirements of Commercial Standard CS 256-63, or latest revision.

**L. PVC FITTINGS**

1. Fittings for use with PVC pipe shall be Schedule 40 fittings produced from PVC Type 1, cell classification 12454-B. The fittings shall be listed by the National Safety Foundation for potable water services. The fittings shall be listed by IAPMO for water service and gas yard piping in appropriate types and sizes. PVC fittings shall meet the following codes and specifications: ASTM-D1784, ASTM-D2466.

**M. PVC CEMENT**

1. Cement for use on PVC fittings shall be NSF approved for Type I and Type II PVC pipe and schedule 40 fittings. Cement is to meet ASTM D-2564 and F-493 for potable water, pressure, gas conduit and drain pipes. Application temperature shall be 35 to 110 degrees Fahrenheit.

**N. WIRE SPLICING KITS**

1. Wire splicing kits for single U.F. wire connections shall be direct burial kits consisting of sealant which shall not set-up hard allowing splices to be reworked without cutting wires.
2. Direct burial kits shall have an application temperature range of 32 to 120 degrees Fahrenheit and service 600 VAC maximum.
3. D.B.Y. kits shall allow connections of two to five #18 AWG or two #12 AWG solid or stranded copper wires. D.B.R. kits shall allow connections to two to five #16 AWG or three #10 AWG solid or stranded copper wires.

**O. BRONZE GATE VALVE**

1. The bronze gate valve shall be constructed with non-rising stem, solid wedge disc and screwed ends. The body, bonnet and disc shall be made from #85-5-5-5 bronze, ASTM B62. The stem, lock nut, packing nut and gland follower shall be made of brass, ASTM B16, with the gland packing made of asbestos graphite. The hand wheel shall be constructed of cast iron, ASTM A126.

2. The gate valve shall have a working non-shock pressure of 125 psi for saturated steam and 200 psi for cold water, oil and gas. The body shall have a hydrostatic test pressure of 300 psi and the seat shall be at 200 psi.
3. The gate valve shall be manufactured by Aqua Valve Company, Orinda, CA.

**P. CONTROL AND COMMON WIRE**

1. All control wire shall be #14/1 U.F. direct burial. The common wire shall be #14/1 U.F. direct burial. The wire shall be solid copper and insulated with poly-vinyl chloride. Control wire shall be red in color and common shall be white.
2. Expansion curls shall be provided within 3 feet of each wire connection to a solenoid and at least every 300 feet in length. Expansion curls are easily formed by wrapping at least 5 turns of wire around a rod or pipe 1 inch or more in diameter, then withdrawing rod.

**Q. SWING JOINT ASSEMBLY**

1. All 1" swing joint assemblies for sprinklers shall be pre-assembled units from the factory made of Schedule 80 PVC. Swing joint consists of four 90 degree elbows and one 12 inch long nipple with 90 degree bend on one end. All swing joint assemblies shall be made from virgin PVC Type I, Clel Classification 12454-B material listed for potable water conveyance by NSF. Working pressure shall be 200 psi combined static and surge.
2. The flexible swing joints for 3/4 inch and 1/2 inch inlet sprinklers shall consist of two 90-degree F.P.T. els and a piece of 3/8 inch thick walled polyethylene pipe known as "Funny Pipe" not to be more than 36" in length.
3. All swing joint assemblies and sprinklers attached shall be completely backfilled with sand to within 3" of final grade.
4. The 1 inch assemblies for quick coupling valves shall be made of Schedule 80 PVC swing joint, as manufactured by Lasco.
5. The Schedule 80 swing joints shall be as manufactured by Lasco.

**R. SPARE PARTS**

1. Provide the following extra parts, to be given to the school at the end of the installation: (2) 640 heads, any nozzle & 360 degree arc, (1) P220-26-06 1 1/2" valve, (1) quick coupler key with hose end.



PART 3 - EXECUTION

3.1 DEPTH OF COVER

- A. Minimum depth of cover over piping used as lateral water distribution piping down stream of a control valve shall be 12 inches. Main water distribution piping under continuous pressure shall have 12 to 18 inches of cover.

3.2 TESTING THE SYSTEM

- A. The entire system shall be tested at the normal system working pressure and upon visual inspection of the ground, should any leak be found, it shall be promptly repaired. The line shall then be retested until satisfactory.

3.3 TRENCH SETTLEMENT

- A. If within 18 months from completion date major settlement due to improper compaction occurs and an adjustment in pipe, sprinkler heads, topsoil and seed or paving is necessary to bring the system to the proper level of the permanent grade, the Contractor, as part of the work under this contract, shall make said adjustments without additional cost to the Owner.

3.4 ADJUSTING AND BALANCING THE SYSTEM

- A. All areas of the irrigation shall be inspected to insure proper coverage. If necessary, the Contractor shall adjust or change nozzles of sprinkler heads to correct any over-coverage or under-coverage.

3.5 WATERLINE

- A. The alignment of water line, as shown on the plan, is only approximate and may be changed at the time of construction in order to avoid trees, shrubs, plantings and/or other obstacles.

3.6 ELECTRICAL INSTALLATION

- A. The Contractor will be required to make connections to the building electrical system as is required for the proper operation of the automatic control system.
- B. All control circuitry, whether electrical or hydraulic, passing through the wall of the building or beneath a sidewalk, road or drive shall be installed in a suitable sleeve; whereas in all other locations they shall be installed in the pipe trench and protected by the pipe whenever possible.

- C. The joining of all underground wires shall be by the use of wire nuts covered with Scotchlok per installation instructions provided by the manufacturer.
- D. Install the irrigation controller in the “pump house” building as indicated on the drawings. Install the wire in conduit thru the building and to the outside of the building.

### 3.7 HEAD INSTALLATION

- A. Install ¾” and ½” heads on Funny pipe, 2 el swing joints with up to 36” of 3/8” “Funny Pipe”. Install 1” heads on Lasco 1” x 8” lay, 2 el swing joints.
- B. Backfill the head in clean, native material. Install flush with grade.
- C. Adjust the radius and arc to avoid spraying buildings or into the road. Adjust the locations of the plants in the planting beds to avoid spray disruption.
- D. Attach to the pipe with fpt tees.

### 3.8 VALVE INSTALLATION

- A. Control valves: install on toe end nipples, 6” inlet and outlet, 3” between the gate valve and the control valve. Install a bronze i.p.s. gate valve before the control valve. Install in standard valve box. Use a DBY splice kit for the wire attachment.
- B. Install a line sized gate valve on toe nipples in standard valve boxes.
- C. Install 1” quick coupler valve on a brass el before the backflow for winterization point. Install 1” quick coupler valve on Lasco locking swing joint in econo box.

### 3.9 WATER PIPING INSTALLATION

- A. Install pipe, valves, controls and outlets in accordance with manufacturer's instructions.
- B. Connect to water service at “pump house” building.

### 3.10 CLEAN-UP

- A. The Contractor shall at all times keep the premises on which the work is being done, and the adjoining premises, clean of rubbish caused by his work.

- B. Upon completion of the job, the Contractor shall clean up all debris caused by his work and leave the job in a neat and clean condition. All debris shall be removed from the premises at the Contractor's expense.

**END OF SECTION**

SECTION 32 91 13 - TOPSOIL

Part 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the General Conditions, Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.2 SECTION INCLUDES

- A. Testing, screening, amending, placing and finish grading all stockpiled and borrow topsoil as shown on the Drawings and specified herein.
  - 1. Provide all borrow topsoil and compost necessary to properly complete all lawn and planting operations.
  - 2. Provide min. 6" depth of topsoil/compost mix over the baseball, softball, and multi-use fields.
  - 3. Provide min. 6" depth of topsoil in all lawn seeding areas.
  - 4. Provide min. 18" depth of topsoil in all planting beds.

1.3 RELATED SECTIONS

- A. Section 31 14 00 - Strip and Stockpile Existing Topsoil
- B. Section 31 23 16 - Earthwork
- C. Section 32 80 00 - Irrigation System
- D. Section 32 92 00 - Seed and Sod Lawn
- E. Section 32 93 00 - Landscape Planting

1.4 QUALITY ASSURANCE

- A. Topsoil
  - 1. Testing: Representative samples of borrow topsoil and stockpiled topsoil shall be completely analyzed/ tested to determine:

- a. Nutrient analysis using the Modified Morgan extractant for soil available P, K, Ca, and Mg.
  - b. Soil pH.
  - c. Organic content- determined by loss of weight on ignition.
  - d. Particle size analysis - sand, silt, and clay - analysis shall be determined using the hydrometer or pipette methods of particle size analysis with size fractions based upon size limits established by USDA.
2. Before delivery of any borrow topsoil, furnish the Architect with a 5 gallon sample of material.
  3. Topsoil testing costs shall be borne by the Contractor.
  4. Testing laboratory shall be:

Soils Testing Laboratory  
Horticulture Storage Building  
University of Connecticut  
2019 Hillside Road  
Storrs, CT 06269

Substitute laboratory may be used only if approved by the Owner and Architect.

#### 1.5 SUBMITTALS

- A. Submit topsoil test results for approval.
- B. Submit materials certificates and product data for the following items, clearly marked, to indicate proposed materials. Printed data shall state application rates and amount of product to be added, if applicable.
  1. Soil amendments and conditioners
  2. Compost
- C. Submit batch delivery tickets for the following items, indicating the trade name, the supplier/distributor's name and the amount of product delivered to the contracting firm/project site.
  1. Soil amendments and conditioners
  2. Compost
  3. Processed sand
- D. Submit materials certificate and certified test report for processed sand and gravel.

- 1.6 PRODUCT HANDLING: Coordinate delivery of borrow topsoil such that it is placed as delivered and no stockpiling is required.
- 1.7 PROJECT CONDITIONS:
- A. Verify that subsurface drains are complete and fully functional prior to beginning work of this Section. Protect subsurface drains from failure.
  - B. Coordinate topsoil placement with irrigation equipment installation.

## PART 2 - PRODUCTS

### 2.1 STOCKPILE TOPSOIL

- A. All topsoil stripped from the project site shall be reused and shall be screened to remove all stones and debris 3/4" and larger.
- B. Following topsoil testing, stockpiled topsoil nutrient levels shall be achieved by the Contractor's addition of amendments to the topsoil to meet the optimum nutrient levels specified in the testing laboratory report. Topsoil shall also be modified to meet the USDA Soils Textural Classification percentage of sand, silt and clay for "sandy loam or "fine sandy loam' classifications.
  - 1. Topsoil shall have a pH of 6.0 to 8.0.
  - 2. Organic Matter Content: 3 - 6%.
- C. No stockpiled topsoil material shall be removed from the site unless otherwise directed in writing by the Owner or Owner's Representative. All approved stockpiled topsoil shall remain the property of the owner unless otherwise directed in writing by the Owner or Owner's Representative.

### 2.2 BORROW TOPSOIL (if needed)

- A. Shall be clean, fertile, friable, and well draining; not to contain materials harmful to plant life. All topsoil to be free of any subsoil earth clods, sods, stones over 3/4 inch in any dimension, sticks, roots, weeds, litter and other deleterious material. Topsoil shall be uniform in quality and texture and contain specified organic matter and mineral elements necessary for sustaining healthy plant growth.
- B. Topsoil shall have a pH of 6.0 to 8.0.
- C. Organic Matter Content: 3 - 6%
- D. Nutrient levels shall be achieved by the Contractor's addition of amendments to the topsoil to meet the optimum nutrient levels specified in the testing laboratory report.

- E. Single source of all borrow topsoil is required.
- F. Topsoil shall meet the USDA Soils Textural Classification percentage of sand, silt and clay for "sandy loam or "'fine sandy loam' classifications.
- G. Free of any toxic chemical, waste or any material or condition that would prevent the establishment of a suitable lawn.

2.3 AMENDMENTS/CONDITIONERS: As recommended by the Topsoil Test Report.

2.4 COMPOST

- A. Compost shall be either Pioneer Valley Compost or Agresoil Premium Organic Compost as distributed by: Agresource, phone 800-313-3320 or approved equal.
- B. Compost shall be derived from organic wastes such as food and agricultural residues, animal manures, mixed solid waster and biosolids (treated sewage sludge) that meet all State Environmental Agency requirements. The product shall be well composted, free of viable weed seeds and contain material of a generally humus nature capable of sustaining growth of vegetation, with no materials toxic to plant growth.
- C. Compost shall have the following properties:

Parameters	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Soluble Salts	4.0 mnhos (dS)
C:N ratio	15 - 30:1
Particle Size	<1"
Organic Matter Content	>50%
Bulk Density	<1000 lbs./cubic yard
Foreign Matter	<1% (dry weight)

- D. Compost generator shall also provide minimum available nitrogen and other macro and micro-nutrients to determine fertilizer requirements.

2.5 SAND: Processed to meet the following particle size criteria:

Description	Sieve Mesh	Diameter of sieve (mm)	Allowable range % retained
Gravel	10	2.00	0- 5%
Very coarse sand	18	1.00	0-20% combined with Gravel
Coarse	35	0.50	at least 60% in this range

Medium	60	0.25	at least 60% in this range
Fine	100	0.15	10% maximum
Very Fine	270	0.05	3% maximum
Silt		0.002	5% maximum
Clay		<0.002	3% maximum

In addition, there shall be 100% passing the No. 5 screen (4mm), and no more than 10% combined very fine sand, silt, and clay.

**PART 3 - EXECUTION**

**3.1 TOPSOIL PREPARATION:**

- A. Determine quantity of approved stockpiled topsoil scheduled to be placed. Provide borrow topsoil to complete the work of this Section.
- B. Based on topsoil testing reports, Contractor is to provide amendments and conditioners to topsoil to bring in compliance with project requirements. Bulk mix to produce a homogeneous product. All stockpiled topsoil is to be amended and used on-site.

**3.2 TOPSOIL/COMPOST MIX BLENDING FOR ATHLETIC FIELDS**

- A. Uniformly blend compost with screened topsoil.
- B. Blending operations shall be performed away from, or off to one side of the athletic field. Blending may be accomplished using an approved mechanical mixer or by fold-mixing windrows of the components with a loader or by spreading compost over topsoil and harrowing compost into topsoil prior to removal.
- C. The finished mixture shall be uniformly blended so that when finished, no layering within the soil profile will occur.
- D. Mix Ratio: 10 parts topsoil to 1 part compost.

**3.3 SHAPING AND GRADING OF SUBSOIL AT LAWN AREAS**

- A. At completion of rough grading, shape and grade subgrade areas to lines and levels as noted on the drawings. All approved topsoil is to be spread.
- B. Utilize approved laser-grading equipment for slope control at athletic fields.
- C. Shape subgrade areas to allow placement of uniform depth of topsoil. Adjustments may be necessary due to field conditions. Provide all shaping adjustments at no additional cost to the owner.



- D. Harrow or otherwise loosen the subgrade soil to a depth of 4 inches.
- E. Remove all sticks, stones, or foreign material two (2) inches or greater in dimension from surface. Remove debris and stone off-site.
- F. Compaction: Compact subgrade soils to where fill is required to 80-85% maximum dry density.

3.4 SPREADING TOPSOIL AND TOPSOIL/COMPOST MIXES

- A. Do not apply topsoil materials to the scarified subgrade or gravel layer without approval by the Engineer. No vehicular traffic or rubber tired equipment shall be allowed on finished subgrade. Topsoil materials shall not be spread until topsoil has been amended as required. Topsoil materials shall not be delivered or worked in a frozen or muddy condition.
- B. Uniformly distribute and spread topsoil materials over all graded lawn areas to conform smoothly to the lines, grades, and elevations shown or otherwise required. Maintain consistent depths of material throughout the project area. Install topsoil materials in athletic fields from the sidelines/ edges towards the center of each field.
- C. Manually supply topsoil around all trees to remain. Avoid damage to root systems. Depth of topsoil around existing trees to be determined by Engineer.
- D. Spread topsoil mixtures in two (2) equal lifts in all locations scheduled to receive 8" or more total topsoil thickness. Bottom lift shall be incorporated into the loosened subgrade or gravel layer as applicable, by disking, harrowing, or other approved means.
- E. Place topsoil in layers that will provide the scheduled thickness after natural settlement and light rolling.
- F. Spread topsoil from edges inward toward the middle of areas receiving topsoil. Do not allow equipment directly on the loosened subgrade.
- G. Compaction: Compact topsoil and topsoil/compost mix to 80-85% maximum dry density.
- H. Do not over compact the topsoil. Do not allow rubber-tired equipment on topsoil areas. Use the lightest weight equipment practicable. Sequence operations to minimize the number of equipment passes required.
- I. Track topsoil slopes - parallel to the fall line.
- J. Place topsoil materials only when it can be immediately followed by seeding operations.
- K. Resupply and place topsoil to eroded, settled or damaged areas until all lawn areas are stabilized. Care shall be taken not to damage grass or pavement areas in the replacement to topsoil.

3.5 PROTECTION

- A. Remove weeds prior to lawn development operations. No weeds shall be allowed to go to seed.
- B. Keep heavy equipment, trucks, etc. off topsoil areas at all times.
- C. If over compaction to topsoil occurs, scarify to the full depth of the topsoil and regrade topsoil.

3.6 EXCESS MATERIALS:

- A. Excess approved stockpiled topsoil remains property of Owner and is to be deposited on-site by the Contractor where directed by the Owner.
- B. Other excess material, including tailings from screening operations shall be legally disposed of offsite.

3.7 FIELD QUALITY CONTROL

- A. Following spreading of topsoil, and prior to the start of sodding operations, Contractor to provide certified field survey of athletic field location and elevations, as specified herein.
- B. Finished grade of placed topsoil shall be within a tolerance of +0.0 feet or +0.04 feet to the design grade elevation. Ensure that no areas of ponding are created. Correct any areas outside of this range until as acceptable uniform grade is obtained.

**END OF SECTION**

SECTION 32 92 00 – SEED AND SOD LAWN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions, and General Requirements apply to the work specified in this Section.

1.2 SECTION INCLUDES

- A. Contractor shall provide and install all topsoil, fertilizer, amendments and sod for sod lawns as shown on the Drawings and as specified herein, including, but not necessarily limited to:
  - 1. Fine grading for sod bed.
  - 2. Providing and incorporating amendments necessary for good sod lawn growth.
  - 3. Sod all areas identified on the Drawings as sodded lawn.
  - 5. Providing and installing erosion control systems as necessary.
  - 6. Mowing, watering, and maintaining the sod lawn until established and accepted.
  - 7. Treating all lawn areas with crabgrass and broadleaf weed controls as needed to insure that lawn is free of weeds and crabgrass at time of acceptance.
  - 8. Repair of existing sod lawn areas damaged by the work of this Contract.
  - 9. Protection and security of sod lawn areas. Repair of damage until acceptance of all sod lawn areas.
- B. Contractor to provide and install all topsoil and fine grading for seeded lawns as shown on the Drawings and as specified herein, including:
  - 1. Fine grading for seed bed.
  - 2. Repair of seeded lawn areas damaged by the work of other sections of this Contract.
  - 3. Providing and incorporating amendments as indicated for good seeded lawn growth.
  - 4. Seed all areas identified on the Drawings as seeded lawn.
  - 5. Providing and installing erosion control systems as necessary.

6. Mowing, watering, and maintaining the seeded lawn until established and accepted by the Owner.
7. Treating all lawn areas with crabgrass and broadleaf weed controls as needed to insure that lawn is free of weeds and crabgrass.
8. Protection, security and repair of damage to all seeded lawn areas.

1.3 RELATED SECTIONS

- A. Section 31 25 00 - Sediment and Erosion Control
- B. Section 32 91 13 - Topsoil
- C. Section 32 93 00 - Landscape Planting

1.4 QUALITY ASSURANCE

- A. Qualifications of Installers: Provide at least one person who shall be present at all times during execution of this portion of the Work, who shall be thoroughly familiar with the type of materials being installed and who shall direct all work performed under this Section.
- B. Preventatives and Controls: Prior to the application of the preventatives and controls specified, confirm that each of the materials is permitted in the State of Connecticut.

1.5 PRODUCT HANDLING

- A. Delivery and Storage:
  1. Seed, sod, fertilizer, lime, and chemical preventatives and controls shall be delivered in standard size unopened containers, showing weight, analysis, and name of manufacturer.
  2. Protect materials from deterioration during delivery and while stored at the site.

1.6 GUARANTEE

- A. Duration of guarantee shall be until the completion of the specified maintenance period and until Owner's final acceptance of ALL lawn areas.

1.7 SCHEDULE

- A. Construct seeded and sodded lawns between April 1 and June 1 and between August 15 and October 15 unless otherwise permitted by the Owner's Representative.

1.8 EXISTING WORK

- A. Verify that topsoil surface is true to grade, smooth, free of irregularities, properly installed to the scheduled thickness and in good condition to receive the work of this Section.

1.9 SUBMITTALS:

- A. Provide copies of a material certificate signed by the seed vendor and the Contractor, (stating botanical and common names, percentages by weight, and percentages of purity, germination and weed seed for each 'grass' seed species) certifying that the seed mixture complies with the specified requirements.
- B. Certification by sod source/grower of sod type for approval prior to delivery of sod to the site showing the seed composition and percentages of each grass type proposed in the blend.
- C. Submit materials certificates and product data for the following items, clearly marked, to indicate proposed materials. Printed data shall state application rates and amounts of product to be added, if applicable.
  - 1. Fertilizers
  - 2. Lime
  - 3. Chemical preventatives and controls
- D. Submit batch delivery tickets for the following items, indicating the trade name, the supplier/distributor's name and the amount of product delivered to the contracting firm/project site.
  - 1. Fertilizers
  - 2. Seed mixes

1.10 TOPSOIL TESTING

- A. Insure that topsoil has been tested in accordance with Section 32 91 13.

1.11 INSPECTION AND ACCEPTANCE OF SODDED LAWN AREAS

- A. Submit written notice requesting inspection at least 10 days prior to the anticipated date.
- B. Maintenance responsibilities end with final acceptance which shall be a minimum 60 consecutive calendar days from the date of sodding. Sodded areas will not be accepted in 'pieces' unless specifically agreed to by the Owner. No sodded areas will be accepted prior to the substantial completion of this Contract and prior to the completion of a minimum of 5 mowings.
- C. A satisfactory stand of acceptable grass is defined as:
  - 1. Consisting of a uniform dense stand of established permanent grass species. Engineer will be the judge. Any part of the sod lawn that does not show a uniform dense lawn grass shall be repaired. Sod lawns must be free of weeds, crabgrass, and other undesirable plants, and with no diseases present.
- D. Final acceptance will not be made until all damaged areas, including areas outside the property limits, have been restored to their original conditions by topsoiling, sodding, and other necessary operations.
- E. Upon stabilization of sod lawn areas, erosion control devices and protection fencing shall be removed and disposed of off-site.

1.12 INSPECTION AND ACCEPTANCE OF SEEDED LAWN AREAS

- A. Submit written notice requesting inspection at least 10 days prior to the anticipated date.
- B. Maintenance responsibilities end with final acceptance which shall be a minimum 90 consecutive calendar days from the date of seeding completion. No seeded areas will be accepted prior to the substantial completion of this Contract and prior to the completion of a minimum of 6 mowings. Seeded areas will not be accepted in 'pieces' unless specifically agreed to in writing by the Owner.
- C. A satisfactory stand of acceptable grass is defined as:

Consisting of a uniform dense stand of established permanent grass species. Engineer will be the judge. Any part of the seed lawn that does not show a uniform dense lawn grass shall be repaired. Lawns must be free of weeds, crabgrass, and other undesirable plants, and with no diseases present for the duration of the guarantee period as stated herein.
- D. Final acceptance will not be made until all damaged areas, including areas outside the property limits damaged by construction, have been restored to their original conditions by the addition of topsoil, seeding, re-seeding, and/or other necessary operations.

E. Upon stabilization of seed lawn areas, erosion control devices and protection fencing shall be removed and disposed of off-site.

1.13 PROTECTION AND SECURITY

A. Provide protection and security as necessary to prevent damage to lawn areas by any cause, including malicious vandalism and unauthorized usage, prior to acceptance of sod lawn by Owner.

PART 2 - PRODUCTS

2.1 LIME: ground limestone, 95% passing through a 100 mesh screen. Calcium carbonate equivalency of 90% or higher.

2.2 FERTILIZER:

- A. Topsoil Fertilizer: complete at the ratios recommended in the topsoil test reports.
- B. Starter Fertilizer: guaranteed analysis of 10.20.10.
- C. Secondary Fertilizer: guaranteed analysis of 15.15.15.

2.3 LAWN SEED

A. Provide fresh, clean, new-crop seed; blue tag certified complying with the tolerance for purity and germination established by the Office of Seed Analysis of North America. Provide seed of the grass species, proportions and maximum percentages of weed seed. Provide seed in cleaned, sealed, properly labeled containers. Seed that is wet, moldy, or otherwise damaged will not be accepted. Handle seed in accordance with the manufacturer's recommendations for exposure to extremes of heat, cold, or moisture.

B. LAWN SEED QUALITY:

- 1. Weed Seed: maximum of 0.50%, no noxious weed seed.
- 2. Purity: minimum 97% pure.
- 3. Crop: maximum 0.50%
- 4. Germination Rate: minimum 80%

C. SEED MIXTURE (percent by weight):

- 35% Masterpiece Tall Type Fescue
- 20% Adventure II Tall Fescue
- 20% Kittyhawk SST Tall Fescue/ Aztec Tall Fescue
- 15% Secretariat Perennial Ryegrass
- 5% Famous Kentucky Bluegrass
- 5% Baron Kentucky Bluegrass

2.4 LAWN SOD:

A. Sod shall be a superior sod grown from high quality seed of known origin. Seed is to be inspected by a Certification Agency to assure satisfactory genetic identity and purity, overall high quality, and freedom from noxious weeds at time of harvest. Sod shall be in healthy condition upon delivery to the site.

B. The blend/mix and percentage of grass in sod shall be from the selections and percentages listed below and shall be harvested from one field to insure a uniform color and texture. Percentages of each grass type used in the sod turf are to be within the given range listed below for that type.

- 70-90% TALL FESCUE - One or more of the following varieties: Apache, Arid, Bonanza, Falcon, Jaguar, Mustang, Rebel II
- 10-20% BLUEGRASS - One or more of the following varieties: Benson (A-34), Bristol, Eclipse, P-104, Touchdown
- 0-10% PERENNIAL RYEGRASS - One or more of the following varieties: All Star, Palmer, Pennant, Prelude, Premier, Yorktown II

C. Sod shall be machine cut to uniform soil thickness of five-eighths inch (5/8"), plus or minus one-quarter inch (1/4") at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut eighteen inches (18") wide by sixty inches (60") long (7-1/2 sq. ft.) or rolls four feet (4') wide by fifty feet (50') long (200 sq. ft.). Standard sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically. Sod shall not be harvested or transplanted when the moisture content may adversely affect its survival.

D. Sod shall be harvested, delivered, and transplanted within a period of thirty six (36) hours. Before cutting, sod shall be mowed uniformly at a height of one and one-half inches (1 1/2"). The Engineer may inspect the sod before it is harvested but reserves the right to reject, on or after delivery, any sod which, in their opinion, does not meet with the specifications.



- 2.5 HYDROMULCH: Soil Guard Bonded Fiber Matrix as manufactured by Weyerhaeuser or approved equal.
- 2.6 CHEMICAL PREVENTATIVES AND CONTROLS: Commercial materials labeled for turf maintenance.
- 2.7 WATER: Potable.

**PART 3 - EXECUTION**

**3.1 SODDED LAWN: RATES OF APPLICATION**

- A. Limestone: The rate of application of limestone per thousand (1,000) square feet shall be as follows, depending on the hydrogen ion concentration (pH) shown by a pH test (test to be provided by the Contractor at no additional cost to the City):

<u>pH</u>	<u>Rate (LBS.)</u>
5.0-5.5	100
5.5-6.0	50
6.0-6.8	25
over 6.8	0

- B. Commercial Fertilizer (10-6-4 50% Slow Release): Two (2) applications of acceptable commercial fertilizer shall be applied by machine, each application at the rate of twenty pounds (20 lbs.) per thousand square feet (1,000 s.f.). The first application shall be made at the time of installation of sod as specified.

The second application shall be made approximately six (6) months after the first application. This treatment shall take place during the next appropriate fertilizing season, that is, the following Spring or Fall and shall be subject to the direction of the Engineer. The second application shall be applied to the surface only. Incorporation shall be achieved by thoroughly watering the entire area after application.

- C. Superphosphate: Superphosphate shall be applied by machine at the rate of twenty pounds (20 lbs.) per thousand square feet (1,000 s.f.).
- D. Compost: Compost shall be spread over all areas to be sodded at the rate of 10 parts topsoil to 1 part compost.

**3.2 SODDED LAWN: BED PREPARATION**

- A. Before any sod is placed and prior to installation of in-ground irrigation, if any, all areas to receive sod shall be thoroughly loosened by rototilling to a depth of eight

inches (8"). All sticks, stones, roots, vegetation, or other objectionable material which might interfere with the formation of a finely pulverized sod bed shall be removed from the soil and a uniform smooth grade shall be established.

- B. Hollows, depressions, and gullies shall be raked smooth and filled with topsoil, if necessary to achieve a smooth surface. When added topsoil is four inches (4") or more in depth, it shall be compacted to the satisfaction of the Engineer.

3.3 SODDED LAWN: INSTALLATION

- A. Compost shall be thoroughly incorporated into the top six inches (6") of existing soil. After the compost has been incorporated, limestone, fertilizer, and superphosphate shall be worked into the top three inches (3") of soil.
- B. All areas to receive sod shall be compacted evenly and uniformly using a two-hundred pound (200 lb.) roller. The area shall then be thoroughly watered prior to the placement of sod. After drying out sufficiently, the area shall be considered ready to receive the sod. Sod is not to be delivered or placed in a frozen condition. Sod shall be harvested, delivered, and installed within a period of thirty six (36) hours. No Sod shall be harvested, delivered, or placed when, in the opinion of the Engineer, high temperatures may adversely affect the survival of the Sod.
- C. The first row of sod shall be laid in a straight line with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered with each piece of sod butted close together with no voids between the pieces. Care shall be exercised to ensure that the sod is not stretched or overlapped. Where mechanical equipment is used to lay sod, flotation tires are to be used. The sod shall be rolled immediately after placement and then thoroughly watered.
- D. Sod shall be laid a minimum of four (4) weeks prior to the Final Inspection date to allow the sod to thoroughly knit before being turned over to Owner. All dead sod shall be replaced prior to the Final Inspection. All extra sod and/or plant debris remaining from the preparation procedure shall be removed from the site.

3.4 SEEDED LAWN: RATES OF APPLICATION

<u>Material</u>	<u>Application Rate</u>
Topsoil Fertilizer, Lime and Topsoil Conditioners	As recommended by the topsoil test report.
Grass Seed	5 lbs./1,000 S.F.
Hydromulch	As recommended by manufacturer.
Starter Fertilizer	10 lbs./1,000 S.F.

Crabgrass Preventative	As recommended by the manufacturer.
Lawn Pest/Disease Control	As recommended by the manufacturer.
Soil Insect Control	As recommended by the manufacturer.
Broad Leaf Weed Control	As recommended by the manufacturer.
Secondary Fertilizer	6.5 lbs./1,000 S.F.

3.5 SEEDED LAWN: BED PREPARATION

- A. Apply lime, topsoil fertilizer, and other recommended conditioners at the rates recommended by the topsoil tests in all areas where topsoil and topsoil/compost mix have been installed. Cultivate topsoil to a 4" depth by spring-toothed harrow or other approved methods to thoroughly incorporate amendments into the topsoil. Maintain a loose friable seed bed. At no time will rubber tired loaders or graders having greater compaction than a small farm tractor be allowed on topsoil. Keep all heavy equipment and trucks off prepared topsoil. Do not prepare while ground is wet or frozen.
- B. Provide additional topsoil where and as required to properly meet all proposed finish grades.
- C. Remove any weeds, debris, foreign matter and stones having any dimension greater than 3/4". Remove from property.
- D. Fine grade to a smooth uniform surface. The entire area shall present an even grade with no depressions where water will stand. Grades shall be within 1/2" of designated elevation. Any protective fencing around existing trees shall be removed and disposed of by the Contractor at this time. Topsoil shall be smoothly blended to existing finish grades around trees, erosion control devices and adjacent existing conditions, maintain existing surface drainage patterns. Smoothly round-off all top and toe of slopes. Reinstall erosion control devices and protective fencing as required.
- E. Approval of surface by Engineer shall be obtained before seeding operations begin.
- F. All areas to receive seed shall be compacted evenly and uniformly using a two-hundred pound (200 lb.) roller.
- G. Perform bulk density and compaction tests to monitor degree of soil compaction/seed bed friability where directed. Where required, loosen the seed bed to obtain no greater than 70% of the ASTM D-1557 modified optimum density.

3.6 SEEDED LAWN: DEVELOPMENT

- A. All disturbed areas not developed otherwise shall be developed as lawn with six (6) inches of topsoil as indicated on the drawings and as specified.

3.7 SEEDED LAWN: SEEDING PROCEDURE

- A. Seeding shall be done when wind does not interfere with uniform distribution of hydroseeding mixture.
- B. Apply starter fertilizer, seed and maximum 10% of mulch in one operation by the use of an approved spraying machine. Avoid spraying mix on adjacent surfaces, walks, building walls, and curbs.
- C. Apply remaining 90-100% of the mulch in a second separate application.
- D. Mix materials with water. Keep in an agitated state so that the materials are uniformly suspended in the water. Apply all materials at the specified rates.
- E. Do not overseed with unapproved quick-germinating species.

3.8 SODDED LAWN: ESTABLISHMENT

- A. Contractor shall provide all labor and materials including water, if not available from Town sources, for all watering necessary for rooting of the sod. Soil on sod pads shall be kept moist at all times.
- B. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary and in sufficient quantities to maintain moist soil to a depth of at least four inches (4"). Watering shall be done during the heat of the day to prevent wilting.

3.9 SODDED LAWN: MAINTENANCE

- A. The first mowing shall not be attempted until the sod is firmly rooted and secure in place. Not more than forty percent (40%) of the grass leaf shall be removed by mowing. The grass height shall be maintained between one and one-half inches (1 1/2") and three inches (3"), as directed by the Engineer, until final acceptance on completion of the whole work under this contract.
- B. Any dead or unsatisfactory sod shall be removed and replaced at the Contractor's expense prior to the Final Inspection.

3.10 SEEDED LAWN: ESTABLISHMENT

- A. Maintain a moist seed bed at all times. Water to be provided from submetered site construction source. Water seed bed so that the topsoil is wet to a depth of 2". Apply complete coverage to the seeded area as necessary to insure proper germination conditions.
- B. Protect all lawn areas with barricades, if necessary, to keep all traffic off the area. Repair all damage to lawn areas including topsoil replacement, at no additional cost to owner.
- C. Re-seed all areas which have failed to show a uniform stand of grass after the initial plants have appeared. All areas disturbed/prepared for reseeding in spring or summer shall receive crabgrass preventative.

3.11 SEEDED LAWN: MAINTENANCE

- A. Maintenance Period Required: Contractor shall maintain lawn from immediately after seeding or sodding and shall continue maintenance until final acceptance.
- B. Provide all reseeding, watering, mowing, weeding, insect or disease control, re-fertilizing, repair of washouts and other maintenance procedures which are necessary to produce a uniform stand of grass.
- C. Grass must be maintained at a height of 1 1/2 - 3". Mowing frequency shall be weekly minimum and must be adequate to insure that no more than 1/3 of the grass blade height is removed at any one time. Remove heavy clippings. The Contractor shall provide a minimum of five (5) mowings. Initial mowing shall occur when grass reaches 2 1/2" height.
- D. Secondary Fertilization: Apply secondary fertilizer 14 days after seeding. Apply per manufacturer recommendations.

3.12 EROSION PREVENTATIVES: Install erosion control system in any seeded areas which receive concentrated run-off water and areas as required by the Owner or Owner's Representative. Erosion control materials shall be secured as recommended by the manufacturer or as indicated on the Drawings.

3.13 CRABGRASS AND BROADLEAF WEED CONTROL

- A. Treat any lawn areas infested with crabgrass or broadleaf weeds with weed control products in conformance with manufacturer's recommendations, as required after identification of weed/crabgrass presence.
- B. Time: Conform to the manufacturer's recommendations.

- C. Rate: Conform to the manufacturer's recommendations.

3.14 DISEASE CONTROL

- A. Treat any diseased lawn areas with proper disease control product in conformance with the manufacturer's recommendations, as required after diagnosis of disease organisms.
- B. Time: Conform to the manufacturer's recommendations.
- C. Rate: Conform to the manufacturer's recommendations.

3.15 PROJECT CLEAN-UP

- A. Upon completion of all lawn areas, remove all excess soil, debris, and other materials resulting from work operations of this Section. Restore all improvements to original condition. Broom clean all walks and pavements. All clean-up shall be completed at the end of each working day.
- B. Upon stabilization of lawn areas, remove all erosion control systems. Re-seed or re-sod as required.

**END OF SECTION**

SECTION 32 93 00 – LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 1 – General Requirements apply.

1.2 SECTION INCLUDES

- A. Provide all labor, materials, equipment, services etc. necessary and incidental for the completion of all landscape work as shown on the drawings and specified herein.
- B. The Contractor shall be liable for any damage to property caused by landscaping operations and all areas and construction disturbed shall be restored to their original condition to the satisfaction of the Engineer.
- C. The Contractor shall carefully correlate his work with that of other Contractors.
- D. The Contractor is required to install and maintain his finished work at his expense as specified.

1.3 RELATED SECTIONS

- A. Section 32 91 13 – Topsoil
- B. Section 32 92 00 – Seed and Sod Lawn

1.4 SUBMITTALS

- A. Manufacturer's Data: Submit copies of the manufacturer's and/or source data for all materials specified, including soils.
- B. Samples: Submit samples of all topsoil, soil mixes, mulches, and organic materials. Samples shall weigh 1 kg (2 lb) and be packaged in plastic bags. Samples shall be typical of the lot of material to be delivered to the site and provide an accurate indication of color, texture, and organic makeup of the material.
- C. Plant Photographs: Submit color photographs of representative specimens of each type of tree and shrub on the plant list. Photos shall be 75 x 125 mm (3 x 5 in.) taken from angle that depicts the size and condition of the typical plant to be furnished. A scale rod or other measuring device shall be included in the photograph. For species where more than 20 plants are required, include a minimum of three photos that show the average plant, the best

quality plant, and the worst quality plant to be provided. Label each photograph with the plant name, plant size, and name of the growing nursery.

- D. Nursery Sources: Submit a list of all nurseries that will supply plants, along with a list of the plants they will provide and the location of the nursery.
- E. Soil Test: Submit soil test analysis report for each sample of topsoil and planting mix per submittal requirements Section 32 91 13 - Topsoil.

#### 1.5 MATERIALS STORAGE AND CLEAN-UP

- A. The Contractor shall keep the premises free from rubbish and all debris at all times and shall arrange his material storage so as not to interfere with the operation of the project. All unused materials, rubbish and debris shall be removed from the site.

#### 1.6 COMPLETION AND ACCEPTANCE

- A. The Contractor shall notify the Engineer when the work of this section is substantially complete. The Engineer shall then review the work and prepare the "punch list" of items remaining or work that is unacceptable. At this time the Engineer may issue the "Notification of Substantial Completion" if the majority of the work is complete to the satisfaction of said Engineer.
- B. The completion of the contract will be accepted and Notice of Completion recorded only when the entire contract is completed to the satisfaction of the Engineer.
- C. Work under this Section will be accepted by the Owner's Construction Representative upon satisfactory completion of all work including "punch list" items.

#### 1.7 WARRANTY

- A. All plant material (tree, shrubs, etc.) and planting supplies (edging, bark mulch, etc.) shall be guaranteed for a period of 18 months from the date of "Notification of Substantial Completion" of the landscaping installation performed under each phase of this contract. The Contractor shall promptly furnish, without cost to the Owner, any and all materials, supplies and labor which prove defective in material and workmanship.

#### 1.8 LANDSCAPE MAINTENANCE

- A. The Landscape Contractor shall maintain his finished work for a period of not less than one (1) year commencing from the time the installation is complete to the satisfaction of the Engineer.
- B. **IMPORTANT:** It is the Contractor's responsibility to determine water application rates. Water plant material if rainfall does not exceed 3/4" in any 8 day period.



- C. The Landscape Contractor shall maintain the landscaping until final acceptance.
- D. Maintenance shall include weeding, cultivating, edging, pruning, repair of minor washouts, soil replacement and other horticultural operations necessary for the proper growth of all plants, and for keeping the entire area within the planting area neat in appearance.
- E. All planting areas shall be cultivated and weeded with hoes or other approved tools within the period from May 1<sup>st</sup> to October 31<sup>st</sup> and such cultivating and weeding shall be repeated at least every three (3) weeks. Under no conditions shall weeds be allowed to attain more than six (6) inches of growth. At the expiration of the guarantee period the area around the tree shall be cultivated and weed free.

## PART 2 - PRODUCTS

### 2.1 TOPSOIL

- A. Refer to Section 32 91 13 - Topsoil

### 2.2 PLANTING SOIL MIXTURE

- A. Topsoil for backfilling plant pits and shrub bed areas shall be mixed with well rotted manure in the following proportions:

Seven (7) cubic yards of topsoil to two (2) cubic yards of manure. They shall be thoroughly mixed by placing the manure evenly over the topsoil piles and turning the piles at least three (3) times or until thoroughly mixed to the satisfaction of the Engineer.

### 2.3 PLANT STOCK

- A. Plant material shall be first quality stock and shall conform to the code of standards set forth in the current edition of the American Standards for Nursery Stock sponsored by the American Association of Nurserymen, Inc.
- B. Species and variety as specified on the drawings and delivered to the site shall be certified true to their genus, species and variety and as defined within the current edition of International Code of Nomenclature for Cultivated Plants, issued by the International Union of Biological Sciences. Substitutions are not permitted without Engineer's written approval.
  - 1. For plant size and types see Drawings for plant list.
- C. Plants shall be nursery grown and shall be of varieties specified in the plant list bearing botanical names.
- D. Planting stock shall be well-branched and well-formed, sound, vigorous, healthy, free from disease, sun-scale, windburn, abrasion, and harmful insects or insect eggs; and shall have healthy, normal unbroken root systems. deciduous trees and shrubs shall be symmetrically

developed, of uniform habit of growth, with straight trunks or stems, and free from objectionable disfigurements. Evergreen trees and shrubs shall have well-developed symmetrical tops with typical spread of branches for each particular species or variety. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Plants budding into leaf or having soft growth shall be sprayed with an anti-desiccant at the nursery before digging.

- E. Stock Sizes: All stock measurements - caliper, height branching level, number of canes, ball sizes shall be in strict accordance with the latest edition of the American Standard for Nursery Stock. Minimum acceptable sizes as specified on the Drawings.
- F. All stock shall be balled and burlapped or container grown stock. Bareroot stock of any kind is unacceptable unless otherwise indicated on the Drawings.

2.4 MULCH FOR PLANTING PITS/BEDS (SHREDDED CEDAR BARK)

- A. Shredded cedar bark mulch shall be a natural forest product composed of shredded bark or wood not exceeding three inches (3") in length and one inch (1") in width. Mulch shall be derived from tree material, not from wood waste or by-products like sawdust, shredded pallets, or other debris. It shall be of a uniform grade and dark brown color with no additives or any other treatment. Mulch with leaves, twigs, and/or debris shall not be acceptable. The pH factor should range from 5.8 to 6.2.

2.5 WATER

- A. Water shall not contain elements toxic to plant life.

2.6 ANTI-DESICCANT

- A. Anti-desiccant shall be an emulsion that will provide a film over plant surfaces permeable enough to permit transpiration, and not damage the plant.

2.7 TREE WOUND DRESSING

- A. Tree wound dressing shall be a black asphalt-base antiseptic paint.

PART 3 - EXECUTION

3.1 GENERAL PREPARATION

- A. Prior to beginning the work of this section, verify that site grading and preparation have been properly completed.

- B. Clearing shall consist of the satisfactory removal and disposal of brush and rubbish occurring within all lawn and planting areas.
- C. UNDERGROUND OBSTRUCTIONS TO PLANTING
  - 1. If underground utilities, are encountered, other locations for planting may be selected by the Engineer. Damage to utility lines shall be repaired at the Contractor's expense at no additional cost to the Owner.
  - 2. Remove all miscellaneous debris below the ground surface and dispose of according to the specifications.
- D. PREPARATION OF PLANTING MIXTURE
  - 1. Before mixing, clean topsoil of roots, plants, sod, stones, clay lumps and other extraneous materials harmful or toxic to plant growth, by screening.
  - 2. To prepare planting mixture mix recommended soil amendments and fertilizers with topsoil at rates specified. Delay addition of fertilizer if planting mixture will not be used within two (2) days.

### 3.2 TREE AND SHRUB PLANTING

- A. All planting shall be performed by personnel familiar with the accepted procedure of planting and under the constant supervision of a qualified planting foreman.
- B. All planting is to be done as shown on drawings and as specified herein and in strict accordance with standard horticultural practices.
- C. PLANTING SEASONS AND CONDITIONS
  - 1. Planting shall be done only when the ground is not frozen, snow covered, or in an otherwise unsuitable condition for planting.
  - 2. Unless otherwise directed by the Engineer, deciduous material shall be planted from March 1st to May 1st and from October 15th to December 15; evergreen material shall be planted from April 1st to May 15th and from September 1st to October 15th, or as approved by the Engineer
- D. LAYOUT
  - 1. Plant material locations and bed outlines shall be staked on the project site by the Contractor and approved by the Engineer before any plant pits or beds are excavated. Plant material locations may be adjusted by the Engineer to meet field conditions.

E. INSTALLATION OF TREES AND SHRUBS

1. Setting Plants:

- a. Balled and burlapped and container-grown plants shall be handled and moved only by the ball or container. Plants shall be set plumb and held in position until sufficient soil has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they are grown in the nursery, collecting field, or container. Fertilizer in tablet form shall be placed prior to backfilling and in accordance with the manufacturer's specifications.
- b. Balled and burlapped stock shall be backfilled with planting soil mixture to approximately half the depth of the ball and then tamped and watered. Burlap and tying materials shall be carefully removed or opened and folded back from top 1/2 of root ball. the remainder of backfill of planting soil mixture shall be tamped and watered. Earth saucers or water basins shall then be formed around the base of each plant.
- c. Container-grown stock shall be removed from containers without damaging plant or root system. Planting shall be completed as specified for balled or burlapped plants.

2. Mulching:

- a. Bark mulch for planting beds shall be installed to a minimum depth of three inches (3") in all areas specified on the landscaping plans.
- b. Prior to the installation of bark mulch all areas to be covered shall be weed free and shall be treated with preemergent herbicide.
- c. Mulching shall take place within 48 hours after planting.
- d. Mulch shall be kept out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.
- e. The top of all areas of bark cover shall be 1" below the top of adjacent curb, walk or edge of pavement.

3. Pruning - New plant material shall be pruned in the following manner:

- a. Dead and broken branches shall be removed. Pruning of deciduous trees and shrubs shall be minimal. Evergreen plants shall not be pruned except to remove dead or broken branches.
- b. Typical growth habit of individual plants shall be retained with as much height and spread as is practicable.
- c. Cuts shall be made with sharp instruments, and shall be flush with trunk or adjacent branch to insure elimination of stubs. "Headback" cuts at right angles to line of

growth shall not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

- d. Trimmings shall be removed from the site.

**END OF SECTION**

SECTION 33 10 00 - WATER DISTRIBUTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.
- C. RWA shall mean South Central Connecticut Regional Water Authority Standard Specifications, latest edition, which document shall be considered as a part of these specifications.

1.2 DESCRIPTION OF WORK

- A. Work under this item shall consist of the installation of a new 6" ductile iron water main and 6" ductile iron fire service connection to existing water main and installation of new water services where shown on the plans or as directed by the Engineer. Work shall also include the installation of blow-offs where shown on the plans or as directed by the Engineer.
- B. Work under this item shall include, but not be limited to:
  - 1. Furnishing and installation of new water main
  - 2. Connecting to existing water main
  - 2. Furnishing and installation of corporation stops
  - 3. Furnishing and installation of curb stops and curb boxes
  - 4. Furnishing and installation of ductile iron or copper piping
  - 5. Testing and disinfection
  - 6. Bituminous pavement repair
- C. Coordinate the Work of this section with Section 02300 - Earthwork and Section 02325 - Trenching.

1.2 RELATED WORK

- A. Section 31 23 16 - Earthwork
- B. Section 31 23 33 - Trenching
- C. Section 32 11 23 - Processed Aggregate Base

D. Section 33 46 23.16 - Broken Stone

### 1.3 SUBMITTALS

- A. Manufacturer's data sheets with specifications for copper tubing, corporation stops, backflow preventers, and curb stops shall be submitted to the Engineer for approval.
- B. Alternative methods of water service installation shall be submitted to the Engineer for approval.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All materials including corporation stops, service saddles, couplings, curb stops, curb boxes shall conform to RWA standard specifications.

### 2.2 WATER MAIN

- A. Water main lines shall be 6 inch diameter ductile iron pipe.

### 2.3 PE FILM, PIPE ENCASEMENT

- A. ASTM A 674 or AWWA C105; PE film, tube, or sheet; 8-mil (0.2-mm) thickness.

### 2.4 COPPER PIPE

- A. Water service lines shall be Type K seamless copper tubing of one (1) inch or two (2) inch nominal diameter. Tubing shall meet the requirements of ASTM Specification B 88 of latest revision.

### 2.5 DUCTILE IRON PIPE AND FITTINGS

- A. AWWA C151, Class 56. Fittings shall be ductile iron or cast iron, AWWA C110, 250 PSI, mechanical joint or AWWA C153, ductile iron compact fittings, 350 PSI, mechanical joint.
- B. Lining: AWWA C104, cement mortar, seal coated.
- C. Gaskets: AWWA C111, rubber.
- D. Encasement: AWWA C105, polyethylene film tube.

- 2.6 WATER METER: Coordinate the furnishing and installation of water meters with the Town of Hamden and the RWA.

**PART 3 EXECUTION**

**3.1 GENERAL**

- A. Testing, disinfection, and permanent pavement repair will be carried out as defined in the pertinent sections of the RWA Specifications.
- B. Trench excavation and backfill will be carried out as defined in Section 31 23 33 - Trenching.
- C. The Contractor shall be responsible for all materials and work required for water service installations, but he will coordinate all activities with the RWA and the Town of Hamden. When temporary discontinuance of service is required to accomplish service replacement, the Contractor shall notify the customer and the RWA and Town of Hamden two (2) full work days in advance of the discontinuance. Contractor shall have all materials on hand necessary to do the work and shall perform as much excavation and installation of new materials as possible in advance to minimize the time water will be shut off.
- D. The excavation and backfill required for water service installation shall be carried out in accordance with the pertinent section of these Technical Specifications.
- E. Tapping ductile iron pipe, installation of corporation stops, installation of corporation stops, installation of curb stops and curb boxes and appurtenant work shall be done in conformity with manufacturer's recommendations and accepted best practice and shall be subject to approval by the RWA, Town of Hamden, and the Engineer.
- F. Where excavations are to be made in bituminous roadways, the existing pavement shall be cut vertically and in straight lines with a pneumatically operated spade or a saw. The Contractor shall dispose of all removed bituminous concrete material in a manner acceptable to the Engineer. Repair of bituminous concrete roadways shall be in accordance with Section 32 12 00 - Bituminous Concrete Pavement and as shown on the Drawings. The Contractor shall replace bituminous pavement to a thickness equal to the existing pavement thickness plus one additional inch.
- G. Where excavations are to be made in grass covered areas, loam and topsoil shall be carefully removed and separately stored to be used again; or, if the Contractor prefers not to separate surface materials he shall furnish, as directed, loam and topsoil at least equal in quality to that excavated.
- H. The Contractor shall be fully responsible for damage done to trees and shrubs as a result of this work. It shall be the Contractor's responsibility to preserve existing trees and shrubs, including those temporarily removed where necessary. All trees and shrubs that are removed, killed, or that have, in the opinion of the Engineer, suffered significant permanent damage shall be replaced, at no additional costs, in an acceptable manner with trees or shrubs approved by the Engineer.



- I. Where it appears as though permanent damage to existing trees and shrubs is unavoidable, the Contractor may petition the Engineer to request moving the curb stop and box from the location specified. The Contractor shall not be allowed to vary the curb stop and box location from that specified above and in the Drawings without specific permission of the Engineer.

**END OF SECTION**

SECTION 33 30 00 - SANITARY SEWER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Furnish and install gravity sewer pipe from a point five (5) feet outside of any building construction to the point of tie-in to the existing public sewer system. This section also includes the following:
  - 1. Trenching, including dewatering and shoring.
  - 2. Backfill and compaction.
  - 3. Connecting to existing sanitary manhole as shown on the Drawings.

1.3 RELATED WORK

- A. Section 31 23 16 - Earthwork
- B. Section 31 23 33 - Trenching

1.4 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary sewerage systems.
- B. Utility Compliance: Compliance with local utility regulations and standards pertaining to sanitary sewerage systems.

1.5 SUBMITTALS

- A. Product data for drainage pipes and specialty products.

- B. Records drawings at project closeout of installed sanitary sewer in accordance with the requirements of Division 1.

## PART 2 PRODUCTS

### 2.1 PVC (POLYVINYL CHLORIDE) SEWER PIPE AND FITTINGS

- A. Gravity Pipe: PVC Sewer Pipe and Fittings conforming to the following:
  - 1. PVC Sewer Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
  - 2. Gaskets: ASTM F 477, elastomeric seals.

### 2.2 CEMENT MASONRY

- A. Cement masonry for plugging existing sanitary sewer lines to be abandoned shall conform to Article M.08.02, Form 816.

### 2.3 IDENTIFICATION

- A. Plastic Underground Warning Tapes: Polyethylene plastic tape, 6 inches wide by 4 mils thick, solid green in color with continuously printed caption in black letters "CAUTION - SEWER LINE BURIED BELOW".

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Prior to installation, ensure excavations and trench bottoms have been prepared in accordance with Section 31 23 33 - Trenching.

### 3.2 INSTALLATION

- A. Coordinate sanitary sewer installation with other project work.
- B. Trenching, including dewatering and shoring, shall conform to the requirements of Section - 31 23 33.
- C. Backfill and compaction shall conform to the requirements of Section 31 23 33 -Trenching.
- D. Install gravity piping beginning at low point of system, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.

Install gaskets and seals in accordance with manufacturer's recommendations. Maintain swab or drag in line and pull past each joint as it is completed.

- E. Use proper size increasers, reducers and couplings where different sizes or materials of pipes and fittings are connected. Reduction of the size or piping in the direction of flow is prohibited.
- F. Install piping to grade and elevations as shown on plans.
- G. Join and install PVC pipe in accordance with ASTM D 3212.

### 3.3 PLUG EXISTING PIPE

- A. Contractor shall plug both ends of existing sanitary pipe that is to be abandoned at the location as shown on the Drawings. The cement masonry must be securely adhered to the pipe to prevent the plug from moving down the pipe. The plug shall be watertight.

### 3.4 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during backfilling of trench for underground water service piping. Locate equidistant between top of pipe and finished grade, directly over piping.

### 3.5 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
  - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
  - 2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.
- B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
  - 1. Make inspections after pipe between designated locations has been installed and approximately two (2) feet of backfill is in place, and again at completion of project.
  - 2. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.
- C. Testing: Pressure test all manholes in accordance with State / Regional / Local / Authority.

**END OF SECTION**

SECTION 33 40 00 - STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 SUMMARY

- A. This Section includes the installation of storm drainage outside the building and the abandonment and removal of existing storm drainage as indicated on the Drawings.

1.3 RELATED SECTIONS

- A. Section 03 30 01 - Portland Cement Concrete (Site)
- B. Section 31 22 13 - Formation of Subgrade
- C. Section 31 23 17 - Unclassified Excavation
- D. Section 31 23 33 - Trenching
- E. Section 32 11 23 - Processed Aggregate Base
- F. Section 33 46 23.16 - Broken Stone
- G. Section 33 49 23 - Stormwater Treatment System

1.4 SUBMITTALS

- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
  - 1. Precast concrete manholes and other structures, including frames, covers, and grates.
  - 2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect and Engineer not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's and Engineer's written permission.

PART 2 - PRODUCTS

2.1 PIPING

- A. Polyethylene Pipe: Corrugated smooth-lined high density polyethylene pipe, type N-12 as manufactured by Advanced Drainage Systems, Inc (ADS). Pipe coupler connections shall be watertight type "Pro-Link WT" by ADS.
- B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for gasketed joints.
  - 1. Gaskets: ASTM C 443, rubber.

2.2 ATHLETIC FIELD SUBSURFACE DRAINAGE PIPING

- A. The work consists of providing all labor, material, equipment and services required for all work described herein, to provide and install corrugated polyethylene pipe for subsurface drainage under athletic field drainage material to collect and convey subsurface water by gravity flow.

**B. MATERIALS**

1. Polyethylene Pipe: Corrugated smooth-lined high density polyethylene pipe, type N-12 as manufactured by Advanced Drainage Systems, Inc (ADS). Pipe coupler connections shall be watertight type "Pro-Link WT" by ADS.
2. Geotextile Fabric: Unless otherwise specified, the pipe trench shall be lined with a non-woven polypropylene geotextile with the following minimum properties:

<b>Fabric Properties</b>	<b>Test Methods</b>	<b>Minimum Average Roll Values</b>
Grab Tensile Strength (lbs.) (weakest principal direction)	ASTM D4632	120
Grab Elongation (%) (weakest principal direction)	ASTM D 4632	60
Trapezoidal Tear (lbs.) (weakest principal direction)	ATSM D4533	40
Mullen Burst (PSI)	ATSM D 3786	90
Puncture (lbs.)	ASTM D4833	30
Permittivity (sec <sup>-1</sup> )	ASTM D4491	0.7
ADS (U.S. Sieve Size)	ASTM D4751	60
U.V. Resistance (% strength retained after 150 hrs. xenon arc)	ASTM D4355	70
Mass per Unit Area	ASTM D5261	3.4

**2.4 MANHOLES**

**A. Precast Concrete Manholes:**

1. Precast Units shall conform to Form 816, Article M.08.02, 4- Precast Units for Drainage Structures and ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
2. Diameter: 48 inches minimum, unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.

4. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated.
7. Gaskets: ASTM C 443, rubber.

**B. Manhole Frames and Covers:**

1. Frames and Grates shall conform to 816, Article M.08.02, 5-Metal for Drainage Structures.
2. ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

**C. Manhole Steps:**

1. Steps shall be aluminum, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.

**2.5 CATCH BASINS**

**A. Precast Concrete Catch Basins:**

1. Precast Units shall conform to Form 816, Article M.08.02, 4- Precast Units for Drainage Structures and ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
2. Base Section: 6-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.

**B. Masonry Catch Basins:**

1. Masonry Units shall conform to Form 816, Article M.08.02, 1- Brick or 2- Concrete Building Brick or 3- Masonry Concrete Units for Catch Basins, Manholes or Drop Inlets.
2. Mortar shall conform to Form 816, Article M.11.04.



C. Catch Basin Frames and Grates:

1. Frames and Grates shall conform to 816, Article M.08.02, 5- Metal for Drainage Structures.

2.6 CONCRETE FOR CAST-IN-PLACE STRUCTURES

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

2.7 STORMWATER TREATMENT SYSTEM

A. Conform to Section 33 49 23 - Stormwater Treatment System

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Sections 31 23 16 - Earthwork and 31 23 33 - Trenching.

3.2 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.
  - 1. Install piping pitched down in direction of flow, at minimum slope of 1/2 of 1 percent, unless otherwise indicated.
  - 2. Install piping with minimum cover as recommended by the manufacturer.
- F. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.3 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 1 inch above finished surface elsewhere, unless otherwise indicated.
- C. Construct cast-in-place manholes as indicated.

3.4 CATCH-BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from storm pipe to cleanout at grade. Use PE or PVC pipe fittings at branches for cleanouts and for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Remove abandoned underground piping indicated on the Drawings to be removed. Backfill for abandoned pipe trench shall conform to Section 31 23 16 - Earthwork.
- B. Abandoned Piping: Close both open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads or with at least 8-inch thick, cast-in-place concrete plug.
  - 2. Close open ends of piping with threaded metal caps, plastic plugs, cast-in-place concrete plugs or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- C. Abandoned Structures: Excavate around structure as required and use one procedure below:
  - 1. Remove structure and close open ends of remaining piping.
  - 2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
  - 3. Backfill to grade according to Section 31 23 16 - Earthwork.

3.7 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
  - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
  - 2. Place plug in end of incomplete piping at end of day and when work stops.

3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- 
- C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
  - D. All existing and proposed piping onsite shall be cleaned/flushed past connection points offsite before construction and after substantial completion of the project. All existing catch basins (and proposed after installation) onsite shall be cleaned prior to start of construction, periodically during construction and again after substantial completion to ensure a clean and properly functioning system throughout the project and after the project is completed.

**END OF SECTION**

SECTION 33 46 23.16 - BROKEN STONE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications (referenced herein as "Form 816").

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Furnish and place broken stone in the locations where shown on the plans or as directed by the Engineer. This stone will be used for drainage applications and other miscellaneous work, as shown on the plans and as directed by the Engineer.

1.3 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements and Town of Hamden Department of Public Works Specifications.
- B. Testing: Compaction tests may be required by the Owner and will be paid for by the Contractor. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All retesting in these areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.

1.4 SUBMITTALS

- A. Submit certified test reports and materials certificates, for products specified in this Section, indicating compliance of all proposed materials with specified requirements.

1.5 PROTECTIONS

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work in conformance with Form 816.

PART 2 PRODUCTS

2.1 BROKEN STONE

- A. Broken Stone shall conform to Article M.05.01, Form 816.
- B. **IMPORTANT:** Material substitutions will not be approved under any circumstances. All recycled materials will be rejected.

PART 3 EXECUTION

3.1 MATERIAL PLACEMENT/COMPACTION

- A. Install broken stone base material at the locations as shown on the Drawings and in accordance with Article 3.04.03 of Form 816. Dimensions specified are after compaction.
- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).

**END OF SECTION**

SECTION 33 49 23 - STORMWATER TREATMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Work Included: The Contractor, and/or a manufacturer selected by the Contractor and approved by the Engineer, shall furnish all labor, materials, equipment and incidentals required and install all precast concrete stormwater treatment systems and appurtenances in accordance with the Drawings and these specifications.

1.3 QUALITY CONTROL INSPECTION

- A. The quality of materials, the process of manufacture, and the finished sections shall be subject to inspection by the Engineer.
  - 1. Such inspection may be made at the place of manufacture, or on the work site after delivery, or at both places, and the sections shall be subject to rejection at any time if material conditions fail to meet any of the specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture.
  - 2. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once.
  - 3. All sections which have been damaged beyond repair during delivery will be rejected and, if already installed, shall be repaired to the Engineer's acceptance level, if permitted, or removed and replaced, entirely at the Contractor's expense.
- B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close textured and free of blisters, cracks, roughness and exposure of reinforcement.
- C. Imperfections may be repaired, subject to the acceptance of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result.
- D. Repairs shall be carefully inspected before final acceptance.
  - 1. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi (28 MPa) at the end of 7 days and 5,000 psi (34 MPa) at the end of 28 days when tested in 3 inch diameter by 6 inch long cylinders stored in the standard manner.

2. Epoxy mortar may be utilized for repairs.

#### 1.4 SUBMITTALS

##### A. Shop Drawings

1. The Contractor shall be provided with dimensional drawings and, when specified, utilize these drawings as the basis for preparation of shop drawings showing details for construction, reinforcing, joints and any cast-in-place appurtenances.
2. Shop drawings shall be annotated to indicate all materials to be used and all applicable standards for materials, required tests of materials and design assumptions for structural analysis.
3. Shop drawings shall be prepared at a scale of not less than 3/16-inches per foot (1:75). Six (6) hard copies of said shop drawings shall be submitted to the Engineer for review and approval.

#### PART 2 - PRODUCTS

##### 2.1 STORMWATER TREATMENT SYSTEM

- A. Each stormwater treatment system shall be Model No. Vortsentry VS 50 as manufactured by Vortechncs, Inc., Scarborough, Maine 04074, phone: 207-885-9830, fax: 207-885-9825; and as protected under U.S. Patent #5,759,415 or approved equal.
- B. Each stormwater treatment system shall be of a type that has been installed and used successfully for a minimum of 5 years. The manufacturer of said system shall have been regularly engaged in the engineering design and production of systems for the physical treatment of stormwater runoff during the aforementioned period.

##### 2.2 ALTERNATE STORMWATER TREATMENT SYSTEMS

- A. Alternate stormwater treatment system shall be as manufactured by CDS Technologies, Inc., Winter Park, FL 32792, telephone: 800-848-9955, fax: 407-681-4916.
- B. Alternate stormwater treatment system shall be the CSR Stormceptor® System as manufactured by CSR, Kansas City, MO 64105; telephone: 800-909-7763 or 816-802-3870, fax: 816-802-3871.
- C. Alternate stormwater treatment system shall meet or exceed the requirements of this specification.



2.3 MATERIALS AND DESIGN

- A. Concrete for precast stormwater treatment systems shall conform to ASTM C857 and C858 and meet the following additional requirements:
  - 1. The wall thickness shall not be less than 6 inches or as shown on the dimensional drawings. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20-44 (MS18) loading requirements as determined by a Licensed Professional Engineer.
  - 2. Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTM C 990.
  - 3. Cement shall be Type II Portland cement conforming to ASTM C150.
  - 4. All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or until 5 days after fabrication and/or repair, whichever is the longer.
  - 5. Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with hydraulic cement conforming to ASTM C595M
- B. Internal aluminum plate components shall be aluminum alloy 5052-H32 in accordance with ASTM B 209.
- C. Sealant to be utilized at the base of the swirl chamber shall be 60 durometer extruded nitrile butadiene rubber (Buna N) and shall be provided to the concrete precaster for installation.
- D. Brick or masonry used to build the manhole frame to grade shall conform to ASTM C32 or ASTM C139 and shall be installed in conformance with all local requirements.
- E. Casting for manhole frames and covers shall be in accordance with ASTM A48, CL.30B and AASHTO M105. The manhole frame and cover shall be equivalent to Campbell Foundry Pattern #1009A or #1012D custom cast with the Vortech logo and the words "Vortechs™ Stormwater Treatment System" or approved equal.
- F. A bitumen sealant in conformance with ASTM C 990 shall be utilized in affixing the aluminum swirl chamber to the concrete vault at the long wall tangent points. The butyle material shall be ¾" thick by ¾" wide.

2.3 PERFORMANCE

- A. The stormwater treatment system specified shall adhere to the following performance specifications at the design treatment capacities:
  - 1. Design Treatment Capacity: 1.1 cfs
  - 2. Sediment Storage: 2.2 cy

- B. Each stormwater treatment system shall include a circular aluminum “swirl chamber” (or “grit chamber”) with a tangential inlet to induce a swirling flow pattern that will accumulate and store settleable solids in a manner and a location that will prevent resuspension of previously captured particulates.
- C. Each stormwater treatment system shall be of a hydraulic design that includes flow controls designed and certified by a professional engineer using accepted principles of fluid mechanics that raise the water surface inside the tank to a pre-determined level in order to prevent the re-entrainment of trapped floating contaminants.
- D. Each stormwater treatment system shall be capable of removing 80% of the net annual Total Suspended Solids (TSS) load based on a 106-micron particle size.
  - 1. Annual TSS removal efficiency models shall be based on documented removal efficiency performance from full scale laboratory tests.
  - 2. Annual TSS removal efficiency models shall only be considered valid if they are corroborated by independent third party field testing. Said field testing shall include influent and effluent composite samples from a minimum of ten storms at one location.
  - 3. The stormwater treatment systems shall have the Design Treatment Capacity listed above, and shall not re-suspend trapped sediments or re-entrain floating contaminants at flow rates up to and including the specified Design Treatment Capacity.
- E. The stormwater treatment systems shall have usable sediment storage capacity of not less than the corresponding volume listed above. The systems shall be designed such that the pump-out volume is less than ½ of the total system volume. The systems shall be designed to not allow surcharge of the upstream piping network during dry weather conditions.
- F. A water-lock feature shall be incorporated into the design of the stormwater treatment system to prevent the introduction of trapped oil and floatable contaminants to the downstream piping during routine maintenance and to ensure that no oil escapes the system during the ensuing rain event. Direct access shall be provided to the sediment and floatable contaminant storage chambers to facilitate maintenance. There shall be no appurtenances or restrictions within these chambers.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Each stormwater treatment system shall be constructed according to the sizes shown on the Drawings and as specified herein. Install at elevations and locations shown on the Drawings or as otherwise directed by the Engineer.
- B. Place the precast base unit on a granular subbase of minimum thickness of six inches (152 mm) after compaction or of greater thickness and compaction if specified elsewhere. The

granular subbase shall be checked for level prior to setting, and the precast base section of the trap shall be checked for level at all four corners after it is set. If the slope from any corner to any other corner exceeds 0.5% the base section shall be removed and the granular subbase material re-leveled.

- C. Prior to setting subsequent sections place bitumen sealant in conformance with ASTM C 990-91 along the construction joint in the section that is already in place.
- D. After setting the precast roof section of the stormwater treatment system, set precast concrete manhole riser sections, to the height required to bring the cast iron manhole covers to grade, so that the sections are vertical and in true alignment with a ¼-inch (6 mm) maximum tolerance allowed. Backfill in a careful manner, bringing the fill up in 6-inch (152 mm) lifts on all sides and compacting the granular bedding to 95% Standard Procter Density per ASTM D698. If leaks appear, clean the inside joints and caulk with lead wool to the satisfaction of the Engineer. Precast sections shall be set in a manner that will result in a watertight joint. In all instances, installation of stormwater treatment systems shall conform to ASTM specification C 891 “Standard Practice for Installation of Underground Precast Utility Structures”.
- E. Holes made in the concrete sections for handling or other purposes shall be plugged with a nonshrink grout or by using grout in combination with concrete plugs.
- F. Where holes must be cut in the precast sections to accommodate pipes, do all cutting before setting the sections in place to prevent any subsequent jarring which may loosen the mortar joints. The Contractor shall make all pipe connections.

**END OF SECTION**

SECTION 34 71 13.27 – TIMBER GUIDE RAIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.2 DESCRIPTION OF WORK

- A. Provide and install timber post guide rail where and as shown on the Drawings.

1.3 RELATED WORK

- A. Section 31 23 16 - Earthwork

1.4 SUBMITTALS

- A. Wood Treatment Data: Submit materials certificate by treating plant indicating chemicals and process used and compliance with specified requirements and all governing ordinances.

1.5 REFERENCES

- A. FS TT-W-550 Wood Preservative – Chromated Copper Arsenate.
- B. FS TT-W-571 Wood Preservative – Treating Practices.
- C. Form 816-2004, State of Connecticut Standard Specifications for Roads, Bridges, and Incidental Construction.

1.6 QUALITY ASSURANCE

- A. Wood Treatment: Comply with American Wood Preservers Association (AWPA) standards for wood preservative treatment schedule.

- B. Provide each piece of lumber factory grade-marked in conformance with AWWA quality mark.
- C. Allowable Tolerances: Guide rail shall not deviate more than ½” in line to grade in section.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials dry during delivery and site storage. Stack materials above ground to ensure proper drainage and ventilation. Protect from weather damage and deterioration.

### PART 2 - PRODUCTS

#### 2.1 TIMBERS – GUIDE RAIL

- A. Rough sawn, No. 2 or better Southern Yellow Pine Timbers.
- B. AWWA grade stamped LP-22 with .40 lbs., p.c.f. retention of waterborne CCA preservative.
- C. Kiln dried or air dried before and after treatment or 25% maximum moisture content.

#### 2.2 POSTS – GUIDE RAIL

- A. Pressure-treated Southern Yellow Pine Wood Posts
  - 1. Rough sawn, No. 2 or better Southern Yellow Pine Timbers.
  - 2. AWWA grade stamped LP-22 with .40 lbs., p.c.f. retention of waterborne CCA preservative

#### 2.3 BOLTS/WASHERS/NUTS

- A. Conform to Article M.10.02-9 of Form 816-2004. Galvanized. Provide with double washers.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Obtain measurements and verify dimensions and details before proceeding with work.

3.2 CONSTRUCTION – GUIDE RAIL

- A. Install timber guide rails where and as shown on the Drawings.
  - 1. Examine materials upon delivery to project site. Damaged or defective timber shall be returned immediately to the manufacturer\supplier.
  - 2. Posts shall be set at a constant vertical alignment above finished grade for each segment of guide rail.
  - 3. Posts shall be aligned in a straight line and held at a consistent distance from the edge of roadway as indicated on the Drawings. Posts shall be firmly installed below grade to the dimensions indicated.
- B. Install rails as detailed. Counter bore rails to receive bolts and double washers. Predrill rail holes.
- C. Finish grade around posts to prepare for site finishing and lawn seeding. Provide topsoil for all proposed lawn areas. Do not allow water to stand adjacent to post bases.

3.3 FINISHING

- A. Exposed edges of all timbers posts, and rails shall be chamfered or routed 2” and lightly sanded to produce eased edges.

3.4 CLEANING

- A. Clean up debris and cuttings on a regular periodic basis.
- B. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, tools, equipment. Repair damage resulting from rough carpentry work.
- C. Dispose of all treated waste lumber in a satisfactory legal manner.

**END OF SECTION**

SECTION 48 16 14 – GEOTHERMAL WELL DRILLING

Part 1 GENERAL

1.01 PURPOSE OF SPECIFICATION

1. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.02 RELATED DOCUMENTS AND PROJECT COORDINATION

1. During the execution of the Work, other contractors and trade personnel associated with project construction may be on-site during the installation, testing, and commissioning of the geothermal system. Contractor shall provide and pay for all temporary construction utilities and services not available but required to complete the Work.
2. For the Geothermal installation, the Contractor shall coordinate with the Owner's Representative regarding all Work including but not limited to permitting, drilling, well installations, excavating, trenching, piping, flushing, flow testing, hydrostatic testing, and backfilling.
3. The Contractor shall provide written requests for all clarifications pertaining to the Contract documents.

1.03 DESCRIPTION OF WORK

1. The closed-loop ground source heat exchanger (CLGSHX) system consisting of two (2) 150-ft deep geothermal wells. The CLGSHX will serve as the heating and cooling source or sink circulation loops connected to the load side of a building HVAC system utilizing ground source heat pump units. The wells are connected by polyethylene heat fusion joined piping formed into vertical loops connected by horizontal headers installed to the geothermal wells.
2. The Work includes furnishing all equipment, materials and labor for the installation and testing for the CLGSHX system as indicated in the contract drawings and specifications.
3. The Work in this Section includes but may not be limited to:
  - a. Drilling and installation of the geothermal wells including advancement through all subsurface materials including obstructions, at the locations and to the depths required. Pre-drilling, pre-excavation, or other methods, if required to overcome obstructions, shall be performed using techniques proposed by the Contractor and accepted through the submittal process defined herein.
  - b. Installation of high density polyethylene (HDPE) U-bend assemblies and grouting into geothermal wells.
  - c. Flushing, flow testing, and pressure testing of the geothermal U-bend assembly before installation and after grouting.
  - d. Capping the installed U-bend assembly.

1.04 RELATED DIVISIONS OR SECTIONS

NOT USED

1.05 DEFINITIONS AND REFERENCE STANDARDS

1. Definitions:
  - a. Contractor: Entity responsible for performing the Work of this Section.
  - b. Owner's Representative: Authorized representatives of the Owner.
  - c. Exchanger Grout: Thermally Enhanced grout installed around U-Tube exchanger.
  
2. Reference Standards
  - a. American National Standards Institute (ANSI)
  - b. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
  - c. American Society of Mechanical Engineers (ASME)
  - d. American Society for Testing Materials (ASTM)
  - e. American Welding Society (AWS)
  - f. American Water Works Association (AWWA)
  - g. International Ground Source Heat Pump Association (IGSHPA)
  - h. National Ground Water Association (NGWA)
  - i. National Sanitation Foundation (NSF)
  - j. U.S. Occupational Safety and Health Administration (OSHA)
  - k. Plastics Pipe Institute (PPI)
  - l. Underground Facilities Protection Organization (UFPO)
  - m. Underwriters Laboratories (UL) or Factory Mutual (FM) Engineering Division
  
3. Should any conflict arise between the contract specifications and the above identified codes and standards the more stringent shall apply without effect to the Owner or Owner's Representative.

1.06 REGISTRATIONS, CERTIFICATIONS, AND LICENSES

1. All drilling shall be conducted by a Connecticut registered well drilling contractor whether employed directly by the Contractor or by hire as a subcontractor.
  
2. All loop installation shall be conducted by personnel certified as a System Fabricator and Installer by IGSHPA or an approved manufacturers' certification program whether employed directly by the Contractor or by hire as a subcontractor.
  
3. All heat fusion shall be conducted by personnel as a Certified Heat Fusion Technician by IGSHPA whether employed directly by the Contractor or by hire as a subcontractor.

1.07 PROJECT CONDITIONS

NOT USED.



## 1.08 QUALITY CONTROL

1. The Contractor shall adhere to the applicable requirements of ASHRAE, IGSHPA, and OSHA Standards, Connecticut Department of Energy and Environmental Protection (DEEP) and to all other applicable ordinances, codes, statutory rules, and regulations of federal, state, and local authorities having jurisdiction over the Work of this Section and other applicable specification Sections.
2. The Contractor shall conduct field testing and measurements to confirm compliance with the requirements of this Section. Contractor shall notify the Owner's Representative 48 hours in advance of each test. The Owner's Representative may also conduct field testing during and/ or after completion of the wells to confirm compliance with the requirements of this Section. The Contractor shall cooperate with the Owner's Representative in all respects to facilitate any testing or observations. After testing is complete, Contractor shall certify system is installed in accordance with Contract Documents and is operating properly.
3. Contractor supplied testing equipment shall be capable of operating in a satisfactory manner and of meeting performance criteria without defects or operational difficulties. If necessary, tests shall be repeated until satisfactory results are consistently obtained at no cost.
4. Work not in conformance with the requirements of this Section shall be improved, or replaced with additional wells that conform to the requirements of this Section, as judged by the Owner's Representative and at no additional cost to the Owner. All costs related to testing of nonconforming Work or materials shall be paid for by the Contractor at no additional cost to the Owner.
5. The presence of the Owner's Representative shall not relieve the Contractor of its responsibility to perform the Work in accordance with the Contract Documents, nor shall it be construed to relieve the Contractor from full responsibility for the means and methods of construction, protection of site improvements against damage, and for safety on the construction site.
6. Tolerances:
  - a. As-installed plan location of the well center shall be within 2 in. of the location shown on the Drawings.

## 1.09 SUBMITTALS

1. Submittal Procedures
  - a. Apply Contractor's stamp to submittal documents and sign or initial to certify that review and verification of the Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
  - b. Schedule submittals to expedite the Project, and deliver to the Owner's Representative. For review of each submittal, allow a minimum of 5 days excluding delivery time to and from the Contractor, for Owner's Representative review. Provide for additional review time where specified.
  - c. If Contractor identifies variations from Contract Documents or Products which may be detrimental to successful performance of the completed Work, Contractor shall identify such variations for the referenced Submittal.

2. Review and Action on Submittals. Each submittal review sheet will be returned to the contractor stamped or marked as follows:
  - a. REVIEWED: The Contractor is advised that this means that fabrication, manufacture and/or construction may proceed providing the Work is in compliance with the Contract Documents.
  - b. REVIEWED AS NOTED: The Contractor is advised that this means that fabrication, manufacture and/or construction may proceed providing the Work is in compliance with the marked notations and the Contract Documents.
  - c. REVIEWED AS NOTED – RESUBMISSION REQUESTED: The Contractor is advised that this means that fabrication, manufacture and/or construction may proceed providing the Work is in compliance with the marked notations and the Contract Documents. The submittal should be corrected and resubmitted for final distribution.
  - d. REJECTED: The Contractor is advised that this means no Work shall be fabricated, manufactured and/or constructed and that the Contractor shall make a new submittal for the project. Product submissions marked with this ACTION or NOTATION will not be permitted on the site.
  - e. In the case of Shop Drawings, returned in the form of manufacturer's descriptive literature, catalog cuts and brochures stamped "REVIEWED" or "REVIEWED AS NOTED", the Contractor shall be responsible for distributing them in the field and to its subcontractors. If the returned Shop Drawings are stamped "REVIEWED AS NOTED RESUBMISSION REQUESTED" or "REJECTED", the Contractor shall submit new copies of Shop Drawings revised to show compliance with the Contract Documents.
  - f. Owner's Representative review and action on the submittals are expressly limited as provided in the Contract Documents and are only to determine compliance with information given in the Contract Documents and conformance with the design concept of the completed project as a whole. Contractor is solely responsible for all matters relating to fabrication, shipping, handling, storage, assembly, installation, and construction, all safety aspects of performing the Work, system integrity and performance, and coordination of the Work.
3. Submittal Packages
  - a. Submittals shall be prepared, and will be reviewed, in Pre- and Post- Construction Submittal Packages as described herein. Submittals contained in each package will be reviewed as a group. Packages containing missing or incomplete submittals will be returned NOT REVIEWED.
  - b. In addition to Pre- and Post- Construction Submittal Packages, the Contractor shall also submit Construction Records throughout the construction period, as described herein.
4. Pre-Construction Submittal Package. A Pre-Construction Submittal Package shall contain all of the following listed below, or will be return in its entirety and coded NOT REVIEWED. No work shall commence prior to complete review of the Pre-Construction Submittal Package.
  - a. Licenses and certifications as follows:
    1. For all drilling contractors, whether employed directly by the Contractor or by hire as a subcontractor, provide proof of current, annual registration as a Connecticut registered well drilling contractor.
    2. For all personnel involved in system installation, whether employed directly by the Contractor or by hire as a subcontractor or subcontracted employee, provide proof of System Fabricators and Installers Certified Installer accreditation from IGSHPA or approved manufacturers' certification program.

3. For all personnel involved in heat fusion, whether employed directly by the Contractor or by hire as a subcontractor or subcontracted employee, Proof of IGSHPA Certified Heat Fusion Technician.
- b. Identify all means and methods of fabrication and installation including the following:
  1. Description of method to control and containerize water and drill cutting spoils.
  2. Schedule for mobilization, set-up, and well drilling, including sequence.
  3. Methods, equipment and devices to be used to advance the wells.
  4. Methods of U-bend pipe installation.
  5. Methods of tremie grouting around U-bend pipe.
  6. Proposed mix designs of Exchanger Grout.
  7. Methods to measure the flow of water being introduced to the well (due to Contractor's installation methods) to the nearest 10 gpm.
  8. Methods to measure the flow of water being taken out of the well to the nearest 10 gpm.
  9. Inside and outside diameter of surface casing and tremie tube
  10. Methods and materials to join surface casings
  11. Diameter of all bits to be used.
  12. Detail of cap to be used.
- c. All permits and approvals required to perform the Work.
- d. Submit manufacturer's product data and cut sheets for all equipment, materials and products to be supplied to complete the Work.
- e. Submit Shop Drawings that consist of detailed layout drawings of the Work Area Layout and System including but not limited to:
  1. location and description of equipment, vehicles, laydown areas, water collection systems, storage areas, and other relevant features,
  2. system piping including pipe lengths and U-bend assemblies,
  3. dimensioned locations of each bore hole,
  4. locations of site utilities,
  5. alignment and grade of horizontal header geothermal loop heat exchanger piping,
  6. Erosion control plan.
  7. Location for on-site stockpile area,
  8. Water treatment and water discharge plan.
- f. Provide warranty documentation showing that the Contractor and pipe manufacturer will meet the warranty requirements indicated herein.
- g. Written Flushing and Testing Plan detailing the means and equipment to be used for system purging, flushing, and hydrostatic testing as required herein, including:
  1. Shop drawings showing flush, flow testing, and hydrostatic testing set up and methods.
  2. Cut sheets of flow meters and pressure gages to be used, including range and smallest dial readings and recent calibration logs.
  3. Cut sheet of pumps to be used for hydrostatic testing and hydrostatic testing methods.
  4. Proposed forms to be used to collect and maintain purge, flow, and hydrostatic pressure test data.
5. Construction Records. During Construction, the following records shall be submitted via email to [pormond@haleyaldrich.com](mailto:pormond@haleyaldrich.com) on the day the activity is undertaken:
  - a. Photo-documentation of installed piping system and separator clips, using the attached form.

- b. Flushing, flow, and hydrostatic tests with separate records for each of these tests conducted.
  - c. Completed well drilling logs indicating conditions encountered, depth of installed casing, water encountered, drilling time, down-time, methods used, top of geologic rock, date of U-bend installation, date of grouting, and other relevant information to record conditions encountered and as-built conditions.
  - d. Logs of recorded water flow measurements encountered during drilling according to methods described herein.
  - e. Results of Exchanger Grout sample testing for hydraulic conductivity and thermal conductivity.
6. Post-Construction Submittal Package. A Post-Construction Submittal Package shall contain the all of the following listed below, or will be returned in its entirety and coded NOT REVIEWED. The Post-Construction Submittal Package shall be submitted within 10 days of project completion.
- a. Record drawings showing all final dimensions, elevations, and locations of all work performed under this contract including locations of the geothermal wells.
  - b. All paperwork and registrations as required by the Connecticut DEEP, including submission of well completion reports to the respective agencies.
  - c. All inspections and approvals from the governing authorities and submit to the Owner's Representative.

1.10 DELIVERY, STORAGE, AND HANDLING

- 1. Coordinate all deliveries and storage locations with Owner's Representative and other site contractors.
- 2. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variations, dirt, dust, and other contaminants.
- 3. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- 4. Protect piping systems from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

1.11 FIELD MEASUREMENTS

- 1. It is the contractor's responsibility to call "Call Before You Dig" to determine if any existing underground utilities are located in the vicinity of the Work, per State regulations. Contractor shall coordinate with the Owner's Representative to verify any Site underground utilities not covered by "Call Before You Dig." If any "marked" or located underground utilities are damaged during the Work, it will be the Contractor's responsibility to properly repair and return the utility to service and restore the site to existing conditions prior to recommencing the Work at no cost to the Owner.
- 2. Coordinate with Owner's Representative to verify set-backs and easements (if applicable); confirm drawing dimensions and elevations prior to commencing the Work.

3. Establish adequate site protection measures for moving, setting up, operating and removal of drill rigs and other support vehicles or equipment, including protection of curbs and sidewalks, protection of existing trees, shrubs and lawn and any potential overhead interferences. Contractor shall inform the Owner's Representative of any obstructions to the drilling operation before actions are taken to remove obstructions. If any "identified" site features are damaged during the Work, it will be the Contractor's responsibility to properly repair and return the site feature to existing conditions prior to recommencing the Work at the expense of the Contractor.

## Part 2 PRODUCTS

### 2.01 WELL MATERIALS

1. Drilling Equipment: Truck-mounted (rubber tire) vehicles capable of advancing wells as specified herein under site conditions at the planned time of installation
2. Casing shall be flush threaded steel casing with no external couplings. Casing shall conform to AWWA Standards and shall have a minimum wall thickness of 0.25 in. or sufficient wall thickness to allow installation into soil and bedrock without having to drill an oversized hole through the soil and bedrock.

### 2.02 EXCHANGER GROUT

1. Exchanger gout shall be CETCO High TC Geothermal Grout or an approved equal high solids cement-bentonite grout having a thermal conductivity equal to or greater than 0.76 BTU/hr-ft-°F and having a hydraulic conductivity less than  $1 \times 10^{-7}$  cm/sec.
2. Sand used for the geothermal grout mixture shall be provided by the contractor and shall be as specified by the grout manufacturer.
3. Exchanger grout shall be mixed and installed according to the manufacturer's specifications.

### 2.03 PIPE SEPARATORS

1. Omega EZ-Snaps manufactured by Geo-Air Industries, or approved equal.
2. GeoClip™ manufactured by GBT, Inc, or approved equal.

### 2.04 HDPE U-TUBE/ PIPE ASSEMBLY AND MATERIALS

1. All piping shall be of high density polyethylene (HDPE) material and shall be manufactured by Performance Pipe – Charter Plastics, DriscoPlex, Lamson Vylon, NuMex Plastics, or approved equal. HDPE pipe must meet the specifications as follows:
  - a. Pipe shall be Schedule 40 with an inside diameter of 1.38-in.
  - b. All HDPE Pipe Dimensions shall be manufactured in accordance with ASTM D-3035.
  - c. All pipe and heat-fused material shall be manufactured from virgin polyethylene extrusion compound material in accordance with ASTM D 3035. Pipe shall be

- manufactured to outside diameters, wall thickness and respective tolerances as specified in ASTM D-3039 or D-2447.
- d. Material shall maintain a 1,600 psi Hydrostatic Design Basis at 73.4 degrees Fahrenheit per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. The material shall be a high-density extrusion compound having a minimum cell classification of PE345434C or higher with a UV stabilizer of C, D, or E as specified in ASTM D-3350 with the exception that this material shall exhibit zero failure (F0) when tested for 192 hours or more under ASTM D-1693, condition C, as required in ASTM D-3350.
  - e. Sufficient information shall be permanently marked on the length of the pipe. The appropriate ASTM pipe standard defines this information. All fittings shall also be similarly marked. Marked information shall include:
    1. Manufacturer's name.
    2. Nominal size.
    3. Pressure rating.
    4. Relevant ASTM standards.
    5. Cell classification number.
    6. Date of manufacture.
  - f. All piping used for the u-bend heat exchanger (pipe located in the borehole) will have factory hot-stamped lengths impressed on the side of the piping indicating the length of the heat exchanger to that point. The length shall read zero on the u-bend end and the actual heat exchanger total length on the other end.
  - g. HDPE fittings shall meet the requirements of ASTM D-2683 (for socket fusion fittings) or ASTM D-3261 (for butt/saddle fusion fittings), and 780 CMR 71.00 Section 7104.2. For connections to equipment and valves with threaded connections, furnish fused transition with reinforced threads. Barbed type fittings shall not be used.
  - h. Eccentric fittings and/or eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur in the system horizontal piping due to the reduction in pipe size. Unless otherwise indicated, eccentric fittings shall be installed to keep the piping flush on the top.

### Part 3 EXECUTION

#### 3.01 GENERAL

1. Contractor shall coordinate with the Owner's Representative regarding trenching, excavation and backfilling and directed by Owner's Representative for placement of geothermal piping systems.
2. Install all piping, fittings, and appurtenances in accordance with Contract Drawings and Specifications as wells as manufacturer's written instructions after inspection and approval by the Contractor.

#### 3.02 WELL DRILLING

1. Advance wells in accordance with approved submittals.

2. Contractor shall anticipate that down-the-hole hammers, roller bits/cones, core barrels, or other similar equipment will be necessary to overcome boulders and cobbles, soil overburden, and bedrock. Telescoping casing may be required to be able to overcome boulders and cobbles to construct the well as specified.
  3. Drilling shall be advanced such that no voids remain around the exterior of the casing and that the annular space between the outside of the casing and the surround soil and rock is less than 1/8 in.
  4. Casing shall be advanced to a minimum of 10 ft below competent rock, as determined by the Owner's Representative.
  5. Casing shall be left-in-place and shall not be extracted.
  6. Rock bore diameter shall be 6-in.
- 3.03 REAL TIME WELL DRILLING FLOW MONITORING; PURGING/CLEANING; QUALITY CONTROL
1. During drilling, measure the flow rate of water being introduced into the well at the ground surface to support the drilling operations. Measure the flow rate of water being extracted from the well, at a minimum, once per hour during drilling and each time significant changes in flow are encountered. Log the data and maintain measurements on site.
  2. Upon completion of each drill, purge and clean each well to remove sediment and other materials from well. Refer to Drawings for testing requirements.
- 3.04 WATER MANAGEMENT, TREATMENT, AND DISCHARGE
1. Construct and provide containers, sheeting, bins, hoses, pumps, and other equipment necessary to collect water from the wellhead such that the water does not leave the rig area or cause erosion.
- 3.05 U-BEND INSERTION AND GROUTING; CIRCUIT AND SYSTEM TESTING
1. Conduct flushing, flow testing, and hydrostatic testing at each well, circuit, and whole system as indicated herein.
  2. Record pressures, flow rates, and other data as indicated herein.
  3. Contractor shall place Pipe Separators at a minimum of 10-ft intervals to position the U-bend pipes against the borehole wall while inserting into each well.
  4. Conduct photo-documentation as require herein, including a prominent display of well number in the photograph and Pipe Separator installation. Photographs shall be date and time stamped and submitted via email on the day the photograph is taken.
  5. Insert U-bend assembly with Pipe Separators into drilled bore.

6. Add additional Exchanger Grout as necessary if top of grout level drops below the ground surface after initial grouting.
7. Collect Exchanger Grout specimens and conduct testing as required on the Drawings.

### 3.06 FLUSHING AND INTEGRITY TESTING

1. After tremie grouting of U-bend in well, conduct flushing of the well to purge air and debris from the U-bend by maintaining a minimum of 9 gpm for the greater of 15 minutes or until air bubbles are observed to be absent from the effluent. Flow rate shall be confirmed with a flow meter capable of measuring flow rate to the nearest 1 gpm, having graduations no larger than 20 gpm on the flow meter dial.
2. After flushing has been completed, apply a target flowrate of 9 gpm and measure the pressure drop across the inlet and outlet of the U-bend for a minimum of 15 minutes. Record pressure drop every 1 minute. Pressure drop shall be measured to the nearest 1 psi using a dial gage containing graduations no larger than 5 psi on the pressure gage dial. Flow rate shall be maintained to within 0.25 gpm of the target flowrate throughout the test. Flow rate shall be measured as stated above. Confirm pressure drop is no greater than 2.5 psi.
3. After the pressure drop test, conduct a hydrostatic pressure test in accordance with ASTM F2164-02 as follows:
  - a. Hold a target test pressure of 90 psi for a minimum of 4 hours. During the four hour period, take readings of hydrostatic test pressure every 5 minutes. Pressure shall be measured with pressure gage capable of reading pressure to the nearest 1 psi using dial gage containing graduations no larger than 100 psi. If measured pressure reduces more than 1 psi, re-apply test pressure to match (not exceed) test pressure.
  - b. Repeat test pressure re-application as necessary for 4 hours.
  - c. If no leaks are detected after maintaining pressure, reduce target test pressure by 10 psi and hold for a duration of 1 hour. Do not add pressure during this period.
  - d. Confirm that target test pressure does not vary more than 5% of test pressure over 1 hour period.
4. Reduce pressure to atmospheric while maintaining water in the U-bend.

### 3.07 CAPPING

1. Cap the well ends using closed HDPE cap.
2. Cap joining shall be by the heat fusion process. Joining shall be of the socket, butt, saddle fusion, or electro-fusion methods in accordance with the pipe manufacturer's procedures.
3. Butt fusion equipment used in the joining procedure shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and interfacial fusion pressure.
4. Butt fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Flanges, unions, grooved couplers, transition



fittings and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion provided one end of these fittings is fusion welded to the HDPE pipe.

5. Contractor shall provide and install ends of HDPE piping in a steel standpipe assembly to serve as temporary protective cover for HDPE piping. Standpipe shall be a minimum 2 ft in length above grade and of sufficient diameter to house a minimum 18 in. length of HDPE piping extending up from the well bore. Contractor shall submit to the Owner for review and acceptance the proposed standpipe assembly.

### 3.08 WARRANTY

1. Contractor shall provide a minimum 50-year warranty to Eli Whitney Regional Vocational Technical School for the HDPE piping materials. Warranty shall name Eli Whitney Regional Vocational Technical School as the beneficiary and the Contractor and pipe manufacturer as the warranty providers.

## Part 4 MEASUREMENT AND PAYMENT

### 4.01 GENERAL

1. Except as provided below, all Work of this Section, including obtaining permits, mobilization/demobilization, equipment procurement or rental, labor, incidentals, and materials shall not be measured, but rather paid as a Base Bid in accordance with item number 48 16 14-1 identified in the table below. The Base Bid shall assume the following:
  - a. 75-ft of casing is required at each well location to meet the requirements of 3.02 Part 4. If more or less well casing than this Base Bid quantity is required, the Contractor shall be compensated or shall provide a credit for the actual casing footage installed in aggregate between the two wells which is more or less than the total quantity provided in the Base Bid. Add/ deduct accepted by the Owner's Representative shall be paid or credited in accordance with item number 48 16 14-2 identified in the table below.
  - b. Between 0 and 50 gallons per minute (gpm) per well is required to be removed from the bedrock to advance the well boreholes to their design depth. Additional equipment, materials, and labor required to drill well boreholes and manage the effluent for conditions where greater than 50 gpm of water per well is encountered in the bedrock requiring continuous removal from the well column to enable drill equipment to be advanced shall not be measured but shall be paid Lump Sum per Well basis in accordance with item 48 16 14-3 identified in the table below.

Item Number	Description	Unit	Quantity	Price
48 16 14-1	Base Bid	Lump Sum	1	\$_____
48 16 14-2	Add/ Deduct Measured Casing	Linear foot	As Necessary	\$___/ft Add/ Deduct from Base Bid of 75-ft at each well
48 16 14-3	Additional Water Discharge (>50 gpm)	Lump Sum per Well	2	\$___/well

Attachment: Separator Installation Record

END OF SECTION

X:\31771\700\Deliverables\Specs\2012-0618 48 16 14 GeothermalWell Spec-F2.docx

**SEPERATOR INSTALLATION RECORD**

E-House  
Geothermal System Installation  
Hamden, Connecticut

Well Number \_\_\_\_\_  
Well and Separator Installation Date \_\_\_\_\_

**COMPLETED RECORD SHALL BE SENT VIA EMAIL TO  
PORMOND@HALEYALDRICH.COM ON SAME DAY OF SEPERATOR INSTALLATION**

