



## **Pico Branch Library at Virginia Avenue Park Santa Monica, CA**

### **100% Construction Documents Specifications – vol. 2**

Distributed: July 24, 2012

Architect's Job No.

**1001**

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TABLE OF CONTENTS

DIVISION	SECTION TITLE	NUMBER OF PAGES
<b>VOLUME 1</b>		
<b>DIVISION 00 – PROCUREMENT &amp; CONTRACTING REQUIREMENTS</b>		
00 01 10	TABLE OF CONTENTS	05
00 07 00	GENERAL CONDITIONS	
00 10 11	PROJECT DIRECTORY	
00 21 13	INSTRUCTIONS TO BIDDERS	
00 41 00	BID FORMS	
<b>DIVISION 01 – GENERAL REQUIREMENTS</b>		
01 10 00	SUMMARY	06
01 21 00	ALLOWANCES	04
01 23 00	ALTERNATES	02
01 25 00	SUBSTITUTION PROCEDURES	04
01 25 01	CHANGE ORDER REQUEST (PROPOSAL)	01
01 25 10	CONTRACTOR'S REQUEST FOR INTERPRETATION	03
01 25 10.1	REQUEST FOR INTERPRETATION FORM	01
01 25 10.2	REQUEST FOR INTERPRETATION LOG	01
01 27 00	UNIT PRICES	03
01 31 00	PROJECT MANAGEMENT AND COORDINATION	05
01 32 33	PHOTOGRAPHIC DOCUMENTATION	01
01 34 00	SUBMITTAL PROCEDURES	10
01 34 00.1	SUBMITTAL TRANSMITTAL FORM	01
01 34 00.2	SUBMITTAL TRANSMITTAL LOG	01
01 40 00	QUALITY REQUIREMENTS	04
01 42 00	REFERENCES	19
01 50 00	TEMPORARY FACILITIES AND CONTROLS	09
01 56 39	TEMPORARY TREE & PLANT PROTECTION	06
01 60 00	PRODUCT REQUIREMENTS	08
01 60 00.1	SUBSTITUTION REQUEST	02
01 73 20	INDOOR AIR QUALITY MANAGEMENT	08
01 74 19	CONSTRUCTION WASTE MANAGEMENT	05
01 77 00	CLOSEOUT PROCEDURES	05
01 78 00	PROJECT RECORD DOCUMENTS	02
01 78 23	OPERATION AND MAINTENANCE DATA	08
01 81 13	SUSTAINABLE DESIGN REQUIREMENTS	12
01 82 00	DEMONSTRATION AND TRAINING	06
01 91 13	GENERAL COMMISSIONING REQUIREMENTS	08
<b>DIVISION 02 – EXISTING CONDITIONS</b>		
02 41 13	SELECTIVE DEMOLITION	07
<b>DIVISION 03 - CONCRETE</b>		
03 10 00	CONCRETE FORMWORK	14
03 20 00	CONCRETE REINFORCEMENT AND EMBEDDED ASSEMBLIES	12
03 30 00	CAST-IN-PLACE CONCRETE	42
03 33 00	LANDSCAPE ARCHITECTURAL CONCRETE	18
03 45 00	PRECAST ARCHITECTURAL CONCRETE	11

# **DIVISION 04 – MASONRY**

04 22 00	CONCRETE MASONRY UNITS	12
----------	------------------------	----

# **DIVISION 05 - METALS**

05 12 00	STRUCTURAL STEEL	22
05 40 00	COLD-FORMED METAL FRAMING	06
05 50 00	METAL FABRICATIONS	10
05 52 00	STAINLESS STEEL RAILINGS	05

# **DIVISION 06 - WOOD & PLASTICS**

06 10 00	ROUGH CARPENTRY	06
06 18 00	GLUED-LAMINATED CONSTRUCTION	04
06 20 00	FINISH CARPENTRY	04
06 40 23	INTERIOR ARCHITECTURAL WOODWORK	12
06 61 16	SOLID POLYMER COUNTERTOPS	04

# **DIVISION 07 - THERMAL & MOISTURE PROTECTION**

07 13 13	RUBBERIZED-ASPHALT SHEET WATERPROOFING	04
07 16 16	CRYSTALLINE WATERPROOFING	04
07 19 16	WATER-REPELLENT & GRAFFITI CONTROL COATING	05
07 21 00	THERMAL INSULATION	05
07 26 16	BELOW-GRADE VAPOR RETARDER	03
07 27 26	FLUID-APPLIED AIR & WATER BARRIER	08
07 42 00	PREFORMED WALL PANELS	07
07 52 00	PATCHING EXISTING ROOFING	02
07 54 19	THERMOPLASTIC ROOFING	10
07 62 00	FLASHINGS AND SHEET METALWORK	10
07 72 33	ROOF HATCH	03
07 92 00	JOINT SEALANTS	08
07 95 00	SEISMIC JOINT COVER ASSEMBLIES	05

# **DIVISION 08 - OPENINGS**

08 11 13	STEEL DOORS AND FRAMES	07
08 12 15	KD STEEL DOOR FRAMES	03
08 14 16	FLUSH WOOD DOORS	05
08 14 33	STILE & RAIL WOOD DOORS	03
08 31 16	ACCESS DOORS & PANELS	05
08 32 00	MULTI-PANEL SLIDING GLASS DOORS	08
08 43 13	EXTERIOR GLASS ASSEMBLIES	13
08 55 13	ALUMINUM WINDOWS	08
08 60 00	ALUMINUM-FRAMED SKYLIGHT	10
08 62 15	TUBULAR SKYLIGHTS	04
08 71 00	DOOR HARDWARE	20
08 71 13	AUTOMATIC DOOR OPERATORS	08
08 80 00	GLAZING	11
08 91 19	EXTERIOR ALUMINUM WALL LOUVERS	05

# **DIVISION 9 – FINISHES**

09 00 10	CLEANING EXISTING SURFACES	02
09 22 16	NON-STRUCTURAL METAL FRAMING	07
09 22 26	CEILING AND SOFFIT SUSPENSION SYSTEMS	03
09 23 13	ACOUSTICAL PLASTER SYSTEMS	04
09 24 00	LATH AND PORTLAND CEMENT PLASTER	07
09 29 00	GYPSUM BOARD	06
09 31 00	CERAMIC TILE	06
09 61 05	WATER VAPOR EMISSION CONTROL	05

09 65 10	RESILIENT WALL BASE	03
09 65 16	LINOLEUM SHEET FLOORING	05
09 67 70	INTERIOR CONCRETE FLOOR SEALER	04
09 68 13	CARPET TILE	05
09 69 00	ACCESS FLOORING	08
09 72 20	PRESENTATION DRY ERASE WALL COVERING	03
09 80 00	ACOUSTIC INSULATION AND SEALANTS	05
09 83 16	ACOUSTIC PAINT	02
09 90 00	PAINTING	11
09 96 00	HIGH-PERFORMANCE COATINGS	10

**DIVISION 10 - SPECIALTIES**

10 11 23	TACKBOARDS	03
10 14 00	SIGNAGE	07
10 21 13	TOILET COMPARTMENTS AND SCREENS	05
10 28 00	TOILET ROOM ACCESSORIES	04
10 44 00	FIRE EXTINGUISHERS AND CABINETS	04
10 73 16	INSTALLING FLAGPOLE	02
10 99 00	BUILDING SPECIALTIES	02

**DIVISION 11 - EQUIPMENT**

11 31 00	APPLIANCES	02
11 51 16	LIBRARY BOOK DEPOSITORIES	03

**DIVISION 12 – FURNISHINGS**

12 24 00	WINDOW SHADES	08
12 48 16	FLOOR MATS	02
12 93 00	SITE FURNISHINGS	04
12 93 13	BICYCLE PARKING DEVICES	02
12 93 15	BICYCLE LOCKERS	03

**DIVISION 13 - SPECIAL CONSTRUCTION**

13 31 23	FABRIC CANOPY	04
----------	---------------	----

**DIVISIONS 14 – 20**

NOT USED

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## **VOLUME 2**

### **DIVISION 21 – FIRE PROTECTION**

21 10 00	FIRE PROTECTION	21
----------	-----------------	----

### **DIVISION 22 - PLUMBING**

22 05 00	BASIC MATERIALS & METHODS - PLUMBING	27
22 05 01	PLUMBING	06
22 07 00	PLUMBING INSULATION	09
22 08 00	COMMISSIONING OF PLUMBING – DHW SYSTEMS	12
22 21 13	PLUMBING PIPING, VALVES AND SPECIALTIES	22
22 40 00	PLUMBING FIXTURES	03

### **DIVISION 23 – HEATING, VENTILATING & AIR-CONDITIONING**

23 05 00	BASIC HVAC MATERIALS & METHODS	24
23 05 04	MECHANICAL SITE UTILITIES	07
23 05 29	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT	12
23 05 93	TESTING, ADJUSTING & BALANCING	12
23 07 00	HVAC INSULATION	15
23 08 00	COMMISSIONING OF HVAC SYSTEMS	14
23 09 00	INSTRUMENTATION AND CONTROL FOR BMS	14
23 09 02	VARIABLE FREQUENCY DRIVES (VFD)	06
23 21 13	HVAC PIPING, VALVES AND SPECIALTIES	23
23 23 00	REFRIGERANT PIPING SYSTEMS	04
23 31 13	AIR DISTRIBUTION	23
23 31 14	DUCT & COIL CLEANING	03
23 34 13	FANS AND VENTS	07
23 41 00	AIR FILTERS	04
23 74 13	PACKAGED HVAC UNITS	07
23 81 45	SPLIT HEAT PUMP UNITS	07
23 82 19	SMALL CABINET FAN COIL UNITS	08

### **DIVISIONS 24 – 25**

NOT USED

### **DIVISION 26 - ELECTRICAL**

26 01 90	SUPPORT MATERIALS AND METHODS	03
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL	09
26 05 26	GROUNDING AND BONDING	04
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	03
26 05 33	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS	06
26 05 36	CABLE TRAYS FOR ELECTRICAL SYSTEMS	02
26 05 48	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS	05
26 08 00	COMMISSIONING OF ELECTRICAL SYSTEMS AND LIGHTING CONTROLS	13
26 09 23	MODULAR DIMMING CONTROLS	14
26 09 37	PHOTOVOLTAIC SYSTEM	10
26 24 13	SWITCHBOARDS	05
26 24 16	PANELBOARDS	02
26 27 26	WIRING DEVICES	03
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	02
26 33 23	CENTRAL BATTERY EQUIPMENT	06
26 50 00	LIGHTING	20
26 50 01	LIGHTING FIXTURES	66

**DIVISION 27 - COMMUNICATIONS**

27 00 00	COMMUNICATIONS	14
27 05 26	GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS	06
27 11 16	COMMUNICATIONS CABINETS, RACKS, ENCLOSURES	04
27 40 00	AUDIO-VISUAL COMMUNICATIONS	46

**DIVISIONS 28 – 30**

NOT USED

**DIVISION 31 – EARTHWORK**

31 10 00	SITE CLEARING	03
31 20 00	EARTH MOVING	08

**DIVISION 32 – EXTERIOR IMPROVEMENTS**

32 12 16	HOT-MIX ASPHALT PAVING	04
32 12 17	RESIN PAVING	12
32 13 13	CONCRETE PAVING	05
32 13 16	DECORATIVE CONCRETE PAVEMENT	28
32 13 17	LITHOCRETE ARCHITECTURAL CONCRETE PAVING	18
32 13 73	CONCRETE PAVING JOINT SEALANTS	06
32 14 43	INTERLOCKING CONCRETE PAVERS (PERMEABLE PAVING)	06
32 14 45	POROUS PAVING	12
32 84 00	PLANTING IRRIGATION	15
32 90 50	LANDSCAPE BOULDERS	04
32 92 00	TURF & GRASSES	10
32 93 00	PLANTS	30
32 94 46	STAINLESS STEEL TRELLIS SYSTEM	10

**DIVISION 33 – UTILITIES**

33 11 00	WATER UTILITY DISTRIBUTION PIPING	07
33 31 00	SANITARY UTILITY SEWERAGE PIPING	05
33 41 00	STORM UTILITY DRAINAGE PIPING	05

**DIVISION 34 – 48**

NOT USED

**APPENDICES**

APPENDIX A - GEOTECHNICAL REPORT	78
APPENDIX B – LEED SCORECARD	1
APPENDIX C – LIBRARY EQUIPMENT	37
APPENDIX D – CITY OF SANTA MONICA IT SPECIFICATIONS	03

END OF TABLE OF CONTENTS

# **DIVISION 21**

## **FIRE SUPPRESSION**

## SECTION 21 10 00 - FIRE PROTECTION

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 210500 - Basic Materials and Methods, and other Sections in Division 21 specified herein.

#### 1.2 DEFINITIONS

- A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches.
- B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
- C. NICET - National Institute For Certification In Engineering Technologies
- D. Other definitions for fire protection systems are included in referenced NFPA standards.

#### 1.3 DESCRIPTION OF WORK

- A. The work includes new providing and installing a complete and fully operable automatic sprinkler system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the following authorities having jurisdiction.
  - 1. State of California City of Santa Monica Building Department.
  - 2. Fire Prevention Division, Fire Marshal's Office.
- B. Work to be in accordance with criteria of the following design and installation standards:
  - 1. National Fire Protection Association.
    - a. No. 13 - Sprinkler Systems for California
    - b. No. 70 - National Electrical Code.
    - c. No. 101-Life Safety Code.
  - 2. <<Uniform Fire Code (UFC), with latest amendmentsInternational Fire Code (IFC) with state amendmentsUniform Building Code (UBC), Latest edition Edition with latest State of California Amendments Factory Mutual Approval Guide (Product listing, only). Factory Mutual Approval Guide and FM Pamphlet #20 "Rules for Installing Sprinklers" (Product listing and project review).
  - 3. Underwriters Laboratories, Inc.
  - 4. Industrial Risk Insurance Underwriters.
  - 5. Owner's insurance agency.
- C. Work includes but is not limited to the following:
  - 1. Automatic Wet Type Sprinkler System.
  - 2. <<Computer Room: Double interlocked pre-action system.
  - 3. Provide all pipe, fittings, sprinklers, valves, signs, flow switches, tamper switches, protective painting, test connections, drains and tests necessary to make the entire system complete and operative.

4. Coordinate with plumbing contractor for capacity of all sprinkler main, test, and auxiliary drain connections.
5. Valve tags and instruction plates shall be mounted and/or hung per local fire department requirements.

#### 1.4 SUBMITTALS

- A. Product Data: Submit six copies of manufacturer's technical data and installation instructions for fire protection materials and products.
  1. Thirty days after the awarding of contract, contractor shall submit list of manufacturer's names and model numbers for review and comment approval to architect. This list shall identify any prior approved substituted items contractor wishes to use. Do not submit technical data until list has been approved. This is mandatory.
  2. Prior to construction submit for <<review and comment>> <<approval>> items including but not be limited to the following:
    - a. Coordinated layout drawings. Lettering shall be minimum 1/8" high.
    - b. Sprinklers and escutcheons - designating area of use.
    - c. Valves, valve boxes, flow switches, and tamper switches.
    - d. Provide California State Fire Marshal approval numbers for flow switches and tamper switches.
    - e. Pipe, fittings, sway bracing, inserts, anchors and hangers.
    - f. Inspector's test and drain station.
    - g. Fire department connections.
- B. Working Plans: Prepare scaled working plans for fire protection pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, and elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Indicate interface between and spatial relationship to piping and adjacent equipment. Lettering shall be minimum 1/8" high. <<All design work shall be done under supervision of licensed engineer. >>
  1. Spacing of fire sprinklers shall be coordinated with lights, air conditioning outlets, sound speakers, architectural reflected ceiling plan; obstruction from light fixtures and other architectural features; and sprinkler piping shall be coordinated with HVAC ductwork & piping, plumbing, electrical conduit, cable trays and structure prior to the installation. Drawings shall be composite type including mechanical, plumbing and lighting equipment with sprinkler and sprinkler drain piping.
- C. Submittal Drawings: Submit shop drawings to Agency having jurisdiction for approval bearing engineer of record stamp <<bearing preparer's NICET stamp>>. Submit six approved copies, bearing stamp and/or signature of authority having jurisdiction to the Engineer for review, comment and approval.
  1. Contractor shall submit sprinkler head locations to architect for approval.
  2. Each calculation shall include legible schematic of system showing all hydraulic reference points.
- D. Hydraulic Calculations: Prepare hydraulic calculations of fire protection systems. Submit to authority having jurisdiction for approval. Submit six approved copies, bearing stamp, and/or signature of Agency having jurisdiction to Owner's representative for review, comment and approval
  1. Contractor shall submit published piping friction loss data from manufacturer with hydraulic calculations.
- E. Certificate of Installation: Submit certificate upon completion of fire protection piping work, which indicates that work has been tested in accordance with NFPA 13, and also that system is operational, complete, and has no defects.

- F. Maintenance Data: Submit maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approval calculation, certificate of installation, and record drawings in maintenance manual; in accordance with requirements of the General Conditions and of Division 01.
- G. Operating and Maintenance Instructions: Provide the Owner with three sets of operating and maintenance instructions covering completely the operation and maintenance of sprinkler equipment and controls. Manual shall be assembled in a 3-ring binder and arranged in following sections:
1. Site Utilities: Drawings showing location, size, depth of all connections, valve boxes, manholes, etc., as installed.
  2. Section No. 1: A chart tabulating all types of pipefittings, valves, and piping specialties installed in each system.
  3. Section No. 2: A chart tabulating all pressures, valve settings for fire department and sprinkler pressure reducing valves as required by S.F.F.D. Provide pressure reducing valve flow test documentation.
  4. Section No. 3: Manufacturer's brochures of all sprinkler heads.
  5. Section No. 4: Manufacturer's brochures of fire pumps, jockey pump and controllers.
  6. Section No. 5: Tamper switches and flow switches.
  7. Section No. 6: Fire Department connections.
  8. Section No. 7: Fire Extinguishers.
  9. Section No. 8: Fire Hydrants.
  10. Section No. 9: Reproducible copies of approved working drawings prepared to facilitate the actual installation of ductwork and piping. Drawings shall indicate location of all concealed valves, and other apparatus.
  11. Section No. 10: 2 copies of NFPA 25 "Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems."
  12. Section No. 11: Approval Calculations.
  13. Section No. 12: Certificate of Installation.
  14. Section No. 13: Guarantees.
  15. The Contractor is responsible for proper instruction of Owner's personnel for operation and maintenance of all material, equipment and apparatus provided.

#### 1.5 DESIGN DESCRIPTION

- A. This section of the specification combined with any of the contract drawings are intended as a guide to establish a basis of design for the systems required.
- B. Contractor shall examine <<the existing installation,>> the Architectural, Interior Design, Structural, Mechanical and Electrical drawings, layout and install a completely hydraulically sized sprinkler system for all areas. Space shall be provided for any valving and equipment to be used.
1. System shall start 5'-0" from perimeter wall and extend throughout the building. Fire main beyond 5'-0" perimeter is provided under Division 02 work. << System shall start at connection to City main and extend throughout the building.>>
  2. Contractor shall contact Owner's insurance agency to incorporate insurer's design requirements in this layout document. <<Factory Mutual shall review layout drawings and calculations. Incorporate all of their design criteria into documents.>>
- C. Office Areas: The main building shall be served with a wet type sprinkler system. A main riser shall be located in the janitor's closet with sprinkler zone valves on each floor.
- D. Building construction shall include upright heads with tees with 1" outlets for future drop in areas with no ceiling. Areas with ceilings, including finished core areas, lobbies, corridors or

as noted herein shall have concealed and recessed pendant heads installed as part of the base building construction. Unfinished areas shall be provided with upright type heads.

- E. All areas shall be sprinklered as the construction progresses, including accessible pipe chases, etc. Design, provide and install a double interlocked Pre-Action sprinkler system for the computer room. System shall utilize an electric controlled deluge valve by the fire protection contractor controlled by detection and alarm system by the fire alarm design/build contractors. Piping to be pneumatically pressurized for supervisory purposes only. Upon loss of pressure, an alarm will sound and a signal sent to the fire alarm panel. Coordinate with Division 26 work. System will be from one manufacturer.
- F. Pressure restricting devices shall be installed on any branch outlet exceeding 100 PSI.
- G. All electrical devices used for this system shall be compatible with the fire alarm system, refer to Division 26.
- H. Seismic Requirement: All automatic sprinkler systems to be seismically braced (for CA).  
Seismic Requirement: All automatic sprinkler and standpipe system to be seismically braced and anchored for IBC Seismic Zone D, FM and NFPA 13. Submit shop drawings on methods and materials.
  - 1. Do not use NFPA Earthquake Zone Chart.

#### 1.6 HYDRAULIC DESIGN

- A. System shall be a straight line or gridded system per NFPA No. 13 with the following exceptions:
  - 1. For all systems the design area shall be the hydraulically most demanding rectangular area.
  - 2. Minimum pressure for any sprinkler head shall not be less than 7 psi.
- B. Total Combined Inside & Outside Hose Allowances: Hydraulic calculations shall include an allowance for hose streams, added at the point of connection to the water supply.
- C. Safety Factor: 10 Psi, or 10 percent of static and residual pressure, whichever is greater.
- D. Light Hazard Areas: Water density of 0.10 GPM per square foot calculated for an area of 1500 square feet in the most remote location.
- E. Ordinary Group I Hazard Areas: Water density of 0.15 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.
- F. Ordinary Group II Hazard Areas: Water density of 0.20 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.
- G. Extra Group I Hazard Areas: Water density of 0.30 GPM per square foot calculated for an area of 2500 square feet in the most remote locations.
- H. Head spacing shall not exceed the limits described in NFPA Pamphlet No. 13.
  - 1. Light Hazard: 225 sq.ft. (for smooth ceiling).
  - 2. Ordinary Hazard: 130 sq. ft.
  - 3. Extra Hazard: 100 sq. ft.
- I. Maximum floor areas protected by any one sprinkler system riser:
  - 1. Light Hazard: 52,000 sq.ft.
  - 2. Ordinary Hazard: 52,000 sq.ft.

3. Extra Hazard: 40,000 sq. ft.

J. Flow Data: Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.

#### 1.7 RELATED WORK SPECIFIED ELSEWHERE

A. Section 210500: Basic Materials and Methods

B. Division 26: Electrical. Coordinate for electrical wiring of detectors, flow alarm switches, tamper switches, fire alarm bell, for electrical wiring of fuel oil and water tank level alarms, connection by life safety section for remote monitoring <<and starting>> of fire pump, and power to fire pumps. All electrical devices used for this system shall be compatible with the fire alarm system. Coordinate with electrical for electric fire pump motor size and emergency generator sizing.

C. Division 09: Finishes.

D. Division 02: Existing Conditions. Coordinate with General Contractor for excavation for the underground water supply system.

E. Coordination with Plumbing for drain.

#### 1.8 QUALITY ASSURANCE

A. The Contractor for the fire protection installation shall be duly qualified Fire Protection Contractor, experienced and regularly engaged in the installation of fire protection systems with a license classification of C-16. Where local authorities require additional licensing of the Fire Protection Contractor, and/or workmen, such a license shall be mandatory for a prospective Contractor.

1. Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.

2. <<The Fire Protection contractor shall be the Engineer of Record for the automatic sprinkler and standpipe system.>>

3. Permits - The Fire Protection Contractor shall obtain permits for the installation or construction as required for approval and installation of the fire protection system. The Fire Protection Contractor shall submit working plans to the authorities having jurisdiction to obtain approval.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Handle components carefully to prevent damage, denting, and scoring. Do not install damaged components. Damaged components shall be replaced with new components.

B. Store/protect products under provisions of Division 01. Store components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage.

#### 1.10 GUARANTEE

A. Provide a one-year (12 months) guarantee under provisions of Division 01. The guarantee shall include parts, shipping, labor, travel costs, living expenses, required fees, and any other associated cost or expense to repair or replace products or systems. The guarantee period is to begin on the date of acceptance of the fire protection installation by the Owner.



## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All products to be commercial grade, new and of the manufacturer's latest design model. Products manufacturers outside of North America will not be accepted without written approval from engineer prior to submission of bid.
- B. All products to be UL listed and/or FM approved, except for items, which are not required to be listed by code.
- C. All products shall be delivered and stored in original containers. Containers shall be clearly marked or stamped with manufacturer's name and rating.
- D. The following items to be included but specified under Section 210500: Basic Materials and Methods.
  - 1. Hangers and supports.
  - 2. Escutcheons plates, flashings and sleeves.
  - 3. Access panel and doors.
  - 4. Identification markers and signs.
  - 5. Expansion compensators and flexible connectors.
  - 6. Anchors, and seismic restraints.
  - 7. Excavation and backfill.

### 2.2 PIPE AND FITTINGS - ABOVE GROUND

- A. General: The piping products listed below by manufacturer's name and model numbers are the only acceptable materials listed for this project. Substitutions of pipe must be submitted and approved in writing by the architect prior to bid. No copper pipe shall be allowed in the wet fire sprinkler system.
- B. Piping or fittings that show substantial rust or breaks in coating will be removed and replaced.
- C. Allied Tube & Conduit: Schedule 40 black steel, ASTM A-135 stamped on pipe, UV cured acrylic finish; Stockham, Grinnell or Warwick Class 150 threaded malleable, ASTM A197, ASTM A126, or Victaulic roll-grooved fittings and couplings, only.
- D. <<Allied Tube: Scheduled 10 black steel pipe, ASTM A-135 stamped on pipe, UV cured acrylic finish; Victaulic roll-grooved fittings and couplings.>>
- E. <<Plenum Rated CPVC pipe listed for fire protection use. Blazemaster.>>
- F. Pre-action sprinkler piping and fittings shall be Schedule 40 galvanized steel, ASTM A-123.
- G. Shop-weld thread-o-lets may be used in lieu of tee fittings, but field (site) welding will not be permitted.
- H. Mechanical Couplings: Victaulic grooved couplings style 07, 75 or 77, or equal by Gruvlok.
- I. Mechanical Tees: Victaulic style 920, Gruvlok. U-bolt mechanical tees are not acceptable.
- J. Flexible sprinkler connector for ductwork sprinkler application: Flexhead or equal Factory Mutual approved system.

- K. Use rigid couplings where flexibility is not required or provide necessary sway bracing.
- L. Prohibited Piping and Fittings: Copper pipe, <<CPVC pipe>>, pipe less than schedule 40 for threaded or less than schedule 10 for roll grooving; Super 40 "Dyna-Flow", "Dyna-Thread", "Fireflow", XL, Thinwall, "Eddylite" by Bullmoose and Threadable Lightwall pipe are not allowed. POZ-LOK, U-bolt Victaulic style 921 mechanical tees, Victaulic style 99 Roust-A-Bout, Victaulic style 90 Plainlock, Hooker style fitting, quick disconnect, boltless, snap-joint, field drilling or welding of any main or branch lines, and any device specifically prohibited by the local authority having jurisdiction is not allowed. No unions shall be permitted for any size pipe. Plain end fittings are not allowed.

## 2.3 PIPE AND FITTINGS - UNDERGROUND

- A. Class 52 ductile iron pipe and fittings, white, cement lined, mechanical or Tyton joint fittings. Piping to be factory encased with 8 mil polyethylene tube or sheet. Fittings to be double field wrapped with 2" wide, 20 mil vinyl tape, 50% overlap.
- B. Manufacturer: United States Pipe and Foundry, Griffin or Pacific States, only.
- C. Polyvinyl Chloride (PVC) Plastic Pipe:
  - 1. Pipe and fittings: Pipe shall conform to AWWA C900 and shall be plain end or gasket bell-end, pressure Class 150 with cast-iron-pipe-equivalent OD. Fittings shall be gray-iron or ductile-iron conforming to AWWA C110, and shall have cement lining conforming to AWWA C104, standard thickness.
  - 2. Joints and Jointing Material: Joints for pipe shall be push on joints as specified in ASTM D3139. Joints between pipe and metal fittings, valves, and other accessories shall be push on joints as specified in ASTM D3139 or shall be compression type joints / mechanical joints as respectively specified in ASTM D3139 and AWWA C111. Provide each joint connection with an elastomeric gasket suitable for bell or coupling or push-on joints with which it is to be used.
  - 3. Transition from PVC to ductile iron pipe shall occur a minimum of 5 feet from building.
- D. All underground piping for fire mains shall be installed, clamped, anchored, flushed and hydrostatically pressure tested according to the requirements of the authorities and/or agencies having jurisdiction, and NFPA Pamphlets Nos. 13 and 24 and F. M. Handbook of Industrial Loss Prevention.
- E. Anchor underground riser stub to nearest underground connection by means of rodding. Retaining glands with setscrews above grade are not allowed.

## 2.4 UNDERGROUND PIPE COATING:

- A. All underground ferrous piping shall be covered with:
  - 1. Either two coats of 10 Mill Scotch Wrap No. 51, or with;
  - 2. "XTRU-COAT" prefabricated extruded cover with joints sealed with two coats of 10 Mill Scotch Wrap #51.
  - 3. Or approved equal

## 2.5 THRUST BLOCKS

- A. Provide thrust blocks at changes in pipe direction, changes in pipe sizes, dead-end stops and at valves.

- B. Calculate area of undisturbed earth of thrust block based on actual soil conditions and water test pressure of 200 Psi.
- C. Concrete and reinforcing steel shall be as specified in Division 03 and 05. All concrete shall be Class A, unless specified otherwise.
- D. Miscellaneous nuts and bolts shall be stainless steel.

## 2.6 RODS AND CLAMPS

- A. Socket clamps shall be stainless steel; four bolt type, equipped with stainless steel socket clamp washers and nuts Grinnell Fig. 595 and 594, Elcen Fig. 37 and 37X, or equal.
- B. Rods shall be stainless steel, 3/4" diameter.

## 2.7 SPRINKLER HEADS - GENERAL

- A. Sprinkler heads shall be regular automatic concealed recessed closed-type heads of ordinary degree temperature rating except that sprinkler heads installed in the vicinity of heating equipment or in special occupancy areas shall be of the temperature rating as described in NFPA No. 13.
- B. Provide quick response heads in all new light hazard occupancies. <<For existing sprinkler systems, response type to match existing type unless otherwise noted.>>
- C. Provide corrosion-resistant sprinkler heads where they are exposed to weather, moisture or corrosive vapors.
- D. The Contractor shall furnish spare heads. The heads shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating head installed. In addition to the spare heads, the contractor shall furnish not less than two special sprinkler head wrenches. Refer to NFPA 13 section; "Stock of Spare Heads".
- E. <<Provide 1" clearance with escutcheon around penetrations through suspended ceilings per ASCE requirements. >>

## 2.8 SPRINKLER HEADS AND ESCUTCHEONS

- A. Sprinkler heads installed shall be upright , pendent or concealed recessed, as conditions require, and shall be of the following type and finish for the areas designated. Unless otherwise specified, sprinklers shall be small frame type, center bulb capsule for finished areas, fusible link for unfinished areas, and 1/2" orifice. <<Extended coverage heads not allowed in unfinished areas except garages.>> <<Extended coverage sprinkler heads are not allowed.>>

<u>Building Area</u>	<u>Sprinkler Head</u>	<u>Sprinkler Finish</u>	<u>Escutcheon Finish</u>	<u>Temp. Deg.</u>
Unfinished Retail, & Office, Garage & Mechanical Rooms	Upright/Pendant	Brass	None	165°F

<u>Building Area</u>	<u>Sprinkler Head</u>	<u>Sprinkler Finish</u>	<u>Escutcheon Finish</u>	<u>Temp. Deg.</u>
Electrical, Telephone & Switchgear Rooms	Upright	Brass	None	286° F
Finished Ceilings	Semi-recessed Pendant	White	White	165° F
	<<Concealed Pendant	Brass	White Coverplate	165° F>>
Soffit	Flush Sidewall	White	White	165°F
Sidewall	Horizontal Sidewall	Brass	None	165°F

B. Manufacturer: Reliable, Star or Viking.

## 2.9 VALVING

A. 2" or Smaller:

1. Control Valve: OS&Y rising stem type gate valve bronze body, bonnet and disc, copper alloy stem, threaded ends, 175 PSI WOG min. Provide with tamper switch.
2. Check Valve: Swing check type with bronze body, cap and disc, threaded ends, 175 PSI WOG min.
3. Drip Valve: 3/4", cast brass automatic ball drip type, threaded ends, 175 PSI WOG min.
4. Testing Valve: 1-1/4", test and drain, sight glass, 1/2" test orifice, lever operated, 300 psi WOG. Drain to mop sink or drain riser.
5. Main Drain Valve: 2", angle gate valve, bronze body, copper alloy stem, threaded ends, 175 psi WOG. Drain to mop sink or drain riser.

B. 2-1/2" or Larger:

1. Control Valve: Lug type wafer valve with tamper switch, ductile iron body, nickel plated ductile iron disc, stainless steel stem and Buna-N seat, 175 PSI WOG min.
2. Control Valve: OS&Y rising stem type gate valve, cast iron body and bonnet, bronze stem, seat and disc, flanged ends, 175 PSI WOG min. Provide with tamper switch.
3. Check Valve: Swing check type with cast iron body, bolted cap and disc, flanged ends, 175 PSI WOG min.
4. Manufacturer: Grinnell, Stockham, Milwaukee, Mueller, Kennedy, Elkart or AGF.

## 2.10 WET SPRINKLER ALARM CHECK VALVE

A. Contractor shall provide, where required, a completely engineered horizontal wet alarm check valve, retarding chamber, and trim assembly. Viking #H-2, Star or Reliable.

## 2.11 UNDERGROUND WATER VALVE

A. Resilient seated gate, valve, non-rising stem, 2" square valve nut, ductile iron construction with epoxy coated surfaces, both interior and exterior, 250 PSI, mechanical joint ends. Provide yard box and cover.

B. Manufacture: American Darling, Clow, Dresser, or U.S. Pipe.

2.12 VALVE BOXES

- A. Cast iron valve boxes for shutoff valves buried in ground shall be complete with bellbottoms, extension piece, top and cover. Boxes shall be suitable for the types of valves with which they are used. All valve boxes shall have a concrete collar flush with grade.
- B. Lids shall have the applicable letters embossed upon the top surface. Tagging shall match existing lids.
- C. Manufacturer: Tyler, ITT Grinnell, or equal.

2.13 PRESSURE REDUCING VALVES

- A. Sprinkler System: Rough bronze body with red enameled hand wheel with integral check valve of the pressure reducing type. Outlet pressure shall not exceed 165 PSI at maximum system pressures. Pressure settings to be field adjustable.
  - 1. Manufacturer: Zurn #Z-3004
- B. Fire Service: 150 class pressure rating, cast iron body with brass main valve trim, control system cast bronze with stainless steel trim
  - 1. Manufacturer: Cla-Val #90-21UL.

2.14 PRESSURE RELIEF VALVE

- A. Provide 3/4" pressure relief valve on discharge side of Sprinkler system pressure reducing valve. Set to a maximum of 175 PSI.
  - 1. Manufacturer: Zurn #P1000A.

2.15 BACKFLOW PREVENTER

- A. Provide listed backflow prevention device as required by local codes and ordinances. Backflow prevention devices installed in the vertical position shall be approved for that orientation.
- B. Double check detector check valve assembly: Epoxy coated, ductile iron construction, 175 Psig working pressure, complete with two spring loaded "Y" type check valves, "Y" strainer with hose bibb on suction side of assembly, two OS&Y gate valves, test cocks, bypass water meter and bypass doublecheck. Ames Model 3001SS, Febco #856-DCDA, Watts #709-DCDA-OSY, Wilkins #950DA or approved equal
- C. Reduced pressure backflow preventor: Ductile iron construction, 150 Psig working pressure, complete with two spring loaded "Y" type check valves, "Y" strainer with hose bibb on suction side of assembly, one differential relief valve, two OS&Y gate valves and test cocks. Unit shall be tapped on both sides to accommodate installation of test cocks. Febco #860 RPA, Wilkins #975DA, Watts #909-RPDA or approved equal.
- D. Detector check valve assemblies: Ductile iron construction, 150 psig working pressure, complete with spring loaded check valve, two OS&Y gate valves and four test cocks. Febco #800 or approved equal.

2.16 INTEGRAL INSPECTORS ALARM TEST AND SYSTEM DRAIN

- A. Combination system drain and visible orifice insert/sight glass for testing system alarm; with screwed or grooved inlet and outlet connections, Malleable iron hand wheel, EPDM valve seats, maximum working pressure 300 Psi, 1/2" orifice insert, Bronze housing <<with 1/2" pressure relief valve, Watts Regulator Model FP 53L, 175PSI>>, UL listed and FM Approved. Victaulic TestMaster II style 720, or approved equal.
- B. Water pressure gauge, range 0-300 Psi, in 5 Psi increments, brass case - 3-1/2" diameter, 1/4" NPT male pipe connection, UL listed. Locate pressure gauge on riser per code. Star Sprinkler, Ashcroft or approved equal.
- C. Pressure gauge test valve, brass 1/4" screwed ends, 300 Psi WOG. United or approved equal.
- D. All relief, main, auxiliary and equipment drains shall be routed separately to floor drain or air gap fitting (by plumbing).

2.17 TAMPER SWITCHES

- A. Switch shall be mounted so as not to interfere with normal operation of the valve and be adjusted to operate when handle of valve has traveled more than one-fifth the distance of its normal operating position. Electrical Contractor shall provide conduit from switch to fire alarm panel.
- B. Housing shall be of aluminum, acid-treated, primed and finished in baked red enamel. Removal of housing shall cause switch to operate. Inside shall be single pole, double throw micro switch with connection for electrical conduit.
- C. Install on all control valves.
- D. Manufacturer: Potter-Electric, Notifier, Ellenco, or Simplex.

2.18 WATER FLOW ALARM - VANE TYPE

- A. Indicator shall be for either vertical or horizontal installation. Indicator shall not be installed in a fitting that changes direction of water flow and shall have a sensitivity setting to signal any flow of water that equals or exceeds the discharge from one sprinkler head. Provide retarding device to prevent false alarms from line surges.
- B. Whenever a water flow alarm is installed in the piping system, an approved floor control valve shall be provided upstream of the alarm indicator. In addition, a drain is required downstream of the alarm indicator.
- C. Each water flow alarm shall be wired to a Fire System. All wiring and conduits as required will be provided under Division 26. An alarm will automatically activate the local fire alarm system.
- D. Manufacturer: Potter-Electric, Ellenco, Notifier, or Simplex.

2.19 EXTERIOR ALARM

- A. Electric bell, 10" diameter, U.L. listed, weather-proof back box housing, 120 VAC, 99 dB at 10 FT; Potter model PBA12010 or equal.

- B. Electric Horn: Potter-Electric, Ellenco, Notifier, or Simplex weatherproof, 120 VAC.

## 2.20 PRE-ACTION SYSTEM

### A. System Components

1. Deluge Valve
2. Deluge Valve Trim Including:
  - a. Test Drain Valve
  - b. Auxiliary Drain Valve
  - c. Drain Cup
  - d. Drip Check
  - e. Alarm Test Shut off Valve
  - f. Strainer Orifice Check Valve
  - g. Pressure Operated Relief Valve
  - h. Priming Valve
  - i. Emergency Release
  - j. Priming Pressure Gauge and Valve
  - k. Water Supply Pressure Gauge and Valve
3. Water Flow Alarm Trim:
  - a. Alarm Pressure Switch
4. Riser Valves:
  - a. Water Supply Control Valve
  - b. Rubber Seat Check Valve
  - c. System Main Drain Valve
5. System air supply trim:
  - a. System Pressure Gauge and Valve
  - b. Soft Seat Check Valve
  - c. Air Supervisory Pressure Switch
  - d. Air Supply Control Valve
  - e. Dry System Air Supply
6. Release Trim
  - a. Strainer
  - b. Solenoid Valve

## 2.21 FIRE DEPARTMENT CONNECTIONS

- A. Flush wall freestanding unit with individual clapper valves, plugs and chains, locations as indicated on drawings. Escutcheon plate to be lettered as follows; "AUTO SPRINKLER", "DRY STANDPIPE" or "AUTO SPRINKLER AND STANDPIPE". Unit shall be polished chrome, mounted 36" above finished grade. Number of inlets required shall be in accordance with regulations of the Fire Marshal or local fire department.

## 2.22 POST INDICATOR VALVE

- A. Indicator post valve and indicator post. Clow # 2925 or approved equal.
  - 1.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. This system to be installed by an experienced firm regularly engaged in the installation of automatic sprinkler system as specified by the requirements of the Specifications.

### 3.2 PERFORMANCE OF WORK

- A. Examine areas and conditions under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings and in accordance with NFPA Pamphlet No. 13, 14, 20 and 24.
- B. Work to start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed.
- C. Coordinate with other trades as necessary to properly interface components of the sprinkler system.
- D. Follow manufacturer's directions and recommendations in all cases.
- E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

### 3.3 TEMPORARY FIRE PROTECTION

- A. Provide all temporary valving, piping, Siamese connections and other components as directed by the fire agency office during all phases of construction.

### 3.4 INSTALLATION - GENERAL

- A. Fire protection system shall be installed in accordance with the approved Drawings. The finished ceiling is not to be erected until all fire protection piping has been installed, tested, and inspected. Sprinkler heads located in the electrical equipment, elevator, or similar rooms shall be furnished with deflectors to prevent water spray on equipment.
- B. Before connection to the overhead piping, all underground piping shall be flushed with water flowing at velocity and quantity required by the installation standards specified above in this Section of the Specifications.
- C. The arrangement of all pipes shall conform to all architectural requirements and field conditions, shall be as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be permitted only where required to permit the pipes to follow the walls. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, shall be parallel with the walls and other pipes, and shall be neatly spaced. All work shall be coordinated with HVAC, Plumbing, Electrical and Structural work in order to avoid interference and unnecessary cutting of floors or walls. All underground or concealed work shall be inspected before the construction is closed up.
- D. All sprinkler heads to be installed in ceilings throughout the scope of work building as listed in Section 2.6. All areas without ceilings shall have rough brass upright or pendent heads as shown on drawings.
- E. Sprinkler heads in all finished areas are to be installed on a true axis line in both directions, with maximum deviation from the axis line of 1/8 inch plus or minus and shall be plus or minus 1" within center of tile. At the completion of the installation, if any heads are found to exceed the above-mentioned tolerance, they shall be removed and reinstalled.
- F. No pipes or other apparatus shall be installed so as to interfere in any way with full swing of doors.



- G. The arrangement, positions, and connections of pipes, drains, valves, etc., shall be as required by NFPA Pamphlet #13 for all areas to be sprinklered. However, the right is reserved by the Architect to change the location of any item to accommodate conditions, which may arise during progress of the work, without additional compensation for such changes provided that no additional heads are required prior to the installation of the work.
- H. Where required, piping shall be installed concealed in building construction, or through steel beams, to obtain adequate head room.
- I. All pipe throughout the job shall be reamed smooth before being installed. Pipe shall not be split, bent, flattened, or otherwise injured either before or during installation.
- J. Provide protective pans under pipes passing over high voltage electrical bus duct or switchgear equipment. The pan shall be constructed of 12 gauge black iron with a 6 inch lip, the corners being welded to make the pans watertight. Each pan shall be given three coats of Rust-Oleum paint and shall be supported by pipe hangers. The pan shall drain clear of the bus duct or switchgear.
- K. All pipe interiors shall be thoroughly cleaned of foreign matter before installation, and shall be kept clean during installation by plugging or other approved means. Piping shall be covered with visqueen during storage. Piping that shows signs of rusting will be removed from job site and replaced.
- L. Field Connections: Any modifications to system required by field conditions, physical equipment changes or compliance with code regulations shall be made promptly without cost to Owner.
- M. Interference: No piping or sprinkler devices shall interfere with the operations of any door, window or mechanical and electrical systems. No part of this system shall visibly be installed in the physical parameter of any window. <<Sprinkler mains and branch piping shall not interfere with existing or future ceiling, light fixtures and HVAC diffusers.>>
- N. Threaded Pipe: Threads shall be clean cut, standard and tapered. Threads shall be made up using flaked graphite and lubricating oil, piping compound or Teflon tape applied to the male threads only.
- O. Grooved Pipe: Installation shall be as prescribed in the Victaulic Piping Manual only. Holes in the piping are to be made in the fabrication shop, not at the job site. Contractor shall provide at the project site a sample of each type of coupling (threaded, standard grooved coupling and mechanical type), showing complete assembly with pipe connections. <<Couplings will not be installed until samples are approved by the Architect. Architect's approval does not eliminate the Contractor's final approval by the fire agency's office.>>
- P. Keep all pipe and other openings closed to prevent entry of foreign matter. Cover all equipment and apparatus to protect against dirt, water, chemical or mechanical damage, before and during construction period. Restore to original condition all apparatus and equipment damaged prior to final acceptance, including restoration of damaged shop coats of paint.
- Q. Location of sprinkler piping is critical.
  - 1. Where ceiling space is at a minimum under beams location of ductwork takes precedence, coordinate accordingly.
  - 2. Include in base bid (3) two-hour coordination meetings with Owner, Architect, and Engineer for coordination of sprinkler pipe routing.

- 3. Coordinate beam and shear wall penetrations with Structural Engineer. Obtain written approval for all beam penetrations from Structural Engineer.
- R. Tracer wire shall be wrapped and taped to non-metallic underground piping at maximum 20 foot intervals.

### 3.5 EXCAVATION AND BACKFILL

- A. Trench and excavation work shall be done in a neat workmanlike manner, of the depth required by the authorities and/or agencies having jurisdiction. Pipe crown shall not be less than 30 inches below the finished ground surface. After the pipe has been properly tested and inspected, trench shall be backfilled with sand, or an approved sandy material, to a depth of 6 inches above the pipe. Backfill material shall be consolidated by tamping or by saturating with water and vibrating. Subsequent backfill shall consist of the original excavated material, free of organic matter, placed in 6 inch layers and compacted layer by layer by means of power driven vibrators.
- B. Replace to original condition all turf, plants, concrete, asphalt, or other improvements disturbed by trenching. In graded, unpaved areas, backfill trenches with crown 8 inches above the surrounding surface.

### 3.6 SLEEVES AND FLASHINGS

- A. Wherever pipes are exposed and pass through walls, floors, partitions or ceilings, they shall be fitted with chromium plated steel escutcheons held in place with setscrews. Care shall be taken to protect the escutcheons during the course of construction.
- B. Penetrations through fire rated walls and floors shall be sealed with listed mastic of similar fire rating.

### 3.7 HANGERS, INSERTS, SUPPORTS, AND SWAY BRACING

- A. Hangers and supports shall be installed per NFPA #13 sections on Hangers and Protection of Piping Against Damage Where Subject to Earthquake. Provide restraint from movement at end sprinkler on branch line per NFPA 13.
- B. Bending of threaded hanger rod is not allowed. All powder driven anchor pins in concrete are not allowed.

### 3.8 SAFETY TESTING & VERIFICATION

- A. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
- B. Provide NFPA 13 Contractor's Material & Test Certificate Form 85A for above ground piping and Form 85B for underground piping.
- C. Provide manpower to test the function and performance of all Life Safety System components and devices per floor and per zone basis in accordance with the local requirements.

3.9 IDENTIFICATION

- A. In addition to the requirements of Section 210500, provide pipe markers every 20 feet, once in every room, and at each building level traversed, minimum. <<Stencil riser/zone numbers on risers.>>
- B. Provide hydraulic design data nameplates on the riser of each sprinkler system in accordance with NFPA 13
- C. Equipment such as valves, drains, etc., shall be provided with signs that identify type of equipment and service. The tag shall be securely fastened to the handle or spindle of the valve by a brass chain. Furnish four schedules of valves so tagged. There shall also be furnished four diagrammatic charts showing schematically the complete sprinkler system with major control valves and numbers thereof. One set of Schedules and charts shall be mounted in glazed frames located where directed.

3.10 AS-BUILT RECORD DRAWINGS AND CERTIFICATION

- A. As-built Record Drawings are to be kept up-to-date and the Master Copy kept at the job site. Prior to final acceptance of work being approved, these drawings are to be turned over to the Owner's Representative for approval.
- B. Written certification from the insuring agents, and authorities having jurisdiction that the tests were satisfactory.
- C. After installation is complete and tests satisfactorily approved, deliver test certificates and approval by the local Fire Authorities and the FMA to the architect. Final acceptance of sprinkler/standpipe system by Owner's Representative shall be contingent upon receipt of certificate and approval from authorities having jurisdiction and for the delivery of final As-Built Drawings.
- D. Combustible concealed spaces above ceiling to be sprinkered. May areas will have no access upon completion. Addition of access panels will not be permitted.
- E. Space below raised access floor to have all combustible construction covered with G.W.B. and/or sheet metal to avoid sprinklers.

END OF SECTION

# **DIVISION 22**

## **PLUMBING**

SECTION 22 05 00 - BASIC MATERIALS AND METHODS - PLUMBING

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

- A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
  - 1. Compliance with all codes and standards applicable to this jurisdiction.
  - 2. Shop Drawings for Equipment
  - 3. Coordination Documents
  - 4. Record Drawings
  - 5. Start-up Service and Building Commissioning
  - 6. Instruction, Maintenance, and O & M Manuals
  - 7. Work associated with Delivery, Storage, and Handling of products
  - 8. Work associated with provision of Temporary Facilities
  - 9. Preparation of Posted Operating Instructions
  - 10. Meeting Project Safety and Indemnity requirements
  - 11. Proper Cleaning and Closing
  - 12. Supplying proper Warranty information
  - 13. Supply specified Guarantee documentation
  - 14. Design and provision of Supports and Anchors
  - 15. Design and provision of Seismic Restraints and Vibration Isolation
  - 16. Pipe Portals
  - 17. Equipment Rails
  - 18. Access Panels and Doors
  - 19. Identification Markers
  - 20. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

- A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete plumbing systems for the building and shall interface with all existing building systems affected by new construction.
- B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.
- C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

- D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

#### 1.4 DESCRIPTION OF BID DOCUMENTS

- A. Specifications:
  - 1. Specifications, in general, describe quality and character of materials and equipment.
  - 2. Specifications are of simplified form and include incomplete sentences.
- B. Drawings:
  - 1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
  - 2. Before proceeding with work check and verify all dimensions.
  - 3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
  - 4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
  - 5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
  - 6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

#### 1.5 DEFINITIONS

- A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
- B. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
- C. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
- D. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
- E. "Connect": Complete hook-up of item with required service.
- F. "Exposed": Not installed underground or "concealed."
- G. "Furnish": To supply equipment and products as specified.
- H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
- I. "Install": To erect, mount and connect complete with related accessories.

- J. "Lead Free": Materials containing not more than 0.2 percent lead when used with respect to solder and flux and not more than a weighted average of 0.25 percent when used with respect to the wetted surfaces of pipes and pipe fittings, plumbing fittings, and fixtures, providing a specified definition and formula for determining "weighted average".
  - K. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
  - L. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
  - M. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.
  - N. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
  - O. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
  - P. "Shall": An exhortation or command to complete the specified task.
  - Q. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
  - R. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
  - S. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
  - T. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."
  - U. "Wiring": Raceway, fittings, wire, boxes and related items.
  - V. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- 1.6 RELATED WORK SPECIFIED ELSEWHERE
- A. All Division 22 Plumbing sections included herein.
  - B. Division 02: Existing Conditions. Coordinate with Civil Engineer.
    - 1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.
  - C. Division 03: Concrete.
    - 1. All concrete work for Plumbing Division shall be included in Division 22 under the appropriate Sections and shall include:
      - a. Concrete curbs and housekeeping pads for the mechanical equipment.
      - b. Thrust blocks, pads, and boxes for mechanical equipment.
      - c. Coordination of floor drain and floor sink installations in sloped floors.

- D. Division 05
- E. Division 07: Thermal and Moisture Protection.
  - 1. Flashing and sheet metal
  - 2. Sealants and caulking
  - 3. Firestopping
- F. Division 09: Finishes:
  - 1. Division 22 installers shall perform all painting, except where specifically stated otherwise in Division 09.
  - 2. Painting of all exposed steel, piping, equipment, and materials.
  - 3. Paint all exposed gas piping, exterior to the building, yellow.
- G. Division 26: Electrical is related to work of:
  - 1. Power connections to all plumbing equipment
  - 2. Life safety provisions
- H. Division 01, Section 01 81 13, "Sustainable Design Requirements"

#### 1.7 CODES AND STANDARDS

- A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.
- B. Perform all tests required by governing authorities and required under all Division 22 Sections. Provide written reports on all tests.
- C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.
- D. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
- E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
- F. Provide in accordance with rules and regulations of the following:
  - 1. Building Codes enforced by the Authority Having Jurisdiction in California:
    - a. 2010 Building Standards Administrative Code, Part 1, Title 24 C.C.R.
    - b. 2010 California Building Code (CBC), Part 2, Title 24 C.C.R.  
(2009 International Building Code and 2010 California Amendments)
    - c. 2010 California Electrical Code (CEC), Part 3, Title 24 C.C.R.  
(2008 National Electrical Code and 2010 California Amendments)
    - d. 2010 California Mechanical Code (CMC) Part 4, Title 24 C.C.R.  
2009 Uniform Mechanical Code and 2010 California Amendments)
    - e. 2010 California Plumbing Code (CPC), Part 5, Title 24 C.C.R.  
(2009 Uniform Plumbing Code and 2010 California Amendments)
    - f. 2010 California Energy Code (CEC), Part 6, Title 24 C.C.R.
    - g. 2010 California Fire Code, Part 9, Title 24 C.C.R.  
(2009 International Fire Code and 2010 California Amendments)



- h. 2010 California Green building Standards Code (CALGreen), Part 11, Title 24 C.C.R.
      - i. 2010 California Referenced Standards, Part 12, Title 24 C.C.R.
      - j. Title 19 C.C.R. Public Safety, State Fire Marshal Regulations.
    - 2. Building Codes enforced by the Authority Having Jurisdiction for International Code Council (ICC) Codes:
      - a. 2009 International Building Code (IBC) with State Amendments
      - b. 2009 International Mechanical Code (IMC) with State Amendments
      - c. 2006 International Plumbing Code (IPC) with State Amendments
      - d. 2009 International Fire Code (IFC) with State Amendments
      - e. 1999 National Electric Code (NEC) with State Amendments
    - 3. Local, city, county and state codes and ordinances
    - 4. Local Bureau of Buildings
    - 5. Local Health Department
    - 6. Local and State Fire Prevention Districts
    - 7. State Administrative Codes
  - G. Provide in accordance with appropriate referenced standards of the following:
    - 1. NFPA - National Fire Protection Association
    - 2. CSA - Canadian Standards Association
    - 3. ADC - Air Diffuser Council
    - 4. ANSI - American National Standards Institute
    - 5. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
    - 6. ASME - American Society of Mechanical Engineers
    - 7. ASTM - American Society for Testing Materials
    - 8. AWS - American Welding Society
    - 9. AWWA - American Water Works Association
    - 10. FM - Factory Mutual
    - 11. MSS - Manufacturer's Standardization Society
    - 12. NEMA - National Electrical Manufacturer's Association
    - 13. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
    - 14. UL - Underwriter's Laboratories
    - 15. ADA - Americans with Disabilities Act
    - 16. ETL - Electrical Testing Laboratories
    - 17. ASSE - American Society of Sanitary Engineers
    - 18. PDI - Plumbing and Drainage Institute
    - 19. IAPMO - International Association of Plumbing and Mechanical Officials
    - 20. CISPI - Cast Iron Soil Pipe Institute
- 1.8 QUALITY ASSURANCE
- A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.
  - B. Current Models. All work shall be as follows:
    - 1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
    - 2. Replacement parts shall be readily available and stocked in the USA.
  - C. Experience: Unless more stringent requirements are specified in other sections of Division 22, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

## 1.9 GENERAL REQUIREMENTS

- A. Examine all existing conditions at building site.
- B. Review contract documents and technical specifications for extent of new work to be provided.
- C. Provide and pay for all permits, licenses, fees and inspections.
- D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.
- E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.
- F. Coordinate mechanical equipment and materials installation with other building components.
- G. Verify all dimensions by field measurements.
- H. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- K. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
- L. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.
- M. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.
- N. Coordinate the installation of plumbing materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
- O. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- P. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

- Q. All materials (such as insulation, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- R. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.
- S. Products made of or containing asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.
- T. Pipes, pipe fittings, plumbing fittings and fixtures that come into contact with the wetted surface of a public water system or any plumbing in a facility providing water for human consumption shall be "Lead Free".

#### 1.10 MINOR DEVIATIONS

- A. The Drawings are diagrammatic and show the general arrangements of all plumbing work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.
- B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include
  - 1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
  - 2. Minor deviations from the plumbing plans required by architectural and structural coordination.
- C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.
- D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.
- E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

#### 1.11 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
  - 1. The proposed substitution does not affect dimensions shown on drawings.

2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
  3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
  4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

#### 1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
- B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.
- C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.
- D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

#### 1.13 UNIT PRICING SUBMITTALS

- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
- B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer's names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
1. Indicate substituted items.
  2. Identify test and balancing agency.
  3. Identify independent testing laboratory for water analysis.
- C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.
- D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies (PDF) of submittals. Refer to Division 01 for additional requirements.

1.14 COORDINATION DOCUMENTS

- A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all equipment, piping and all system appurtenances with other trades. The Drawings shall include all equipment rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.
- B. The Drawings shall be prepared as follows:
  - 1. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4" = 1'-0" or larger, on reproducible media sheets (vellum) or AutoCAD disks. Obtain reproducibles or AutoCAD files of the HVAC design from the Architect, or Engineer, at cost plus. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping. Plans shall also indicate proposed ceiling grid and lighting layout, as shown on electrical plans and reflected ceiling plans.
  - 2. The Plumbing Contractor shall obtain reproducible plans or AutoCAD disks from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
  - 3. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD disks with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
  - 4. Plans are to incorporate all addenda items and change orders.
  - 5. Distribute plans to all trades and provide additional coordination as needed.
- C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.
- D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.
- E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.
- F. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

#### 1.15 RECORD DRAWINGS

- A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
  - 1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion. Coordinate with Div. 1 requirement.
- B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.
- C. Mark Drawings to indicate revisions to piping size and location both exterior and interior; including locations of control devices, valves, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
- E. Refer also to Special Conditions in Division 01 for full scope of requirements.

#### 1.16 START-UP SERVICE AND BUILDING COMMISSIONING

- A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.
- B. Provide services of factory-trained technicians for start-up of temperature controls, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.
- C. Refer to other Division 22 Sections for additional requirements.

#### 1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

- A. O&M Manuals: Upon completion of the work, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.
- B. The Contractor shall be responsible for proper instruction of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 22 to be no less than 2 hours for each piece of equipment.

1.18 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.
- C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 TEMPORARY FACILITIES

- A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

1.20 POSTED OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.21 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.
- B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.22 CLEANING AND CLOSING

- A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
- B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.23 WARRANTIES

- A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
- B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
- C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.24 GUARANTEE

- A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
- B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
- B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

- A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
  - 1. UL: Provide products, which are UL listed.
  - 2. ASCE 7-05: "American Society of Civil Engineers."
  - 3. 2006 International Building Code (IBC)



4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
  5. SMACNA: "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
  7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
  8. Manufacturer: B-Line, Grinnell, Michigan, Tolco, Kin-Line, Simpson, or Superstrut.
- B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
1. Adjustable Steel Clevis Hangers: MSS Type 1.
  2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
  3. U-Bolts: MSS Type 24.
  4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
    - a. Plate: Unguided type.
    - b. Plate: Guided type.
    - c. Plate: Hold-down clamp type.
  5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
  6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
  7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
  8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
  9. Adjustable Roller Hangers: MSS Type 43.
  10. Pipe Roll Stands: MSS Type 44.
  11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
- C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.
- D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.
- E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
1. Steel Turnbuckles: MSS Type 13.
  2. Steel Clevises: MSS Type 14.
  3. Swivel Turnbuckles: MSS Type 15.
  4. Malleable Iron Eye Sockets: MSS Type 16.
  5. Steel Weldless Eye Nuts: MSS Type 17.
- F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
  2. Steel Brackets: One of the following for indicated loading:
    - a. Light Duty: MSS Type 31.
    - b. Medium Duty: MSS Type 32.
    - c. Heavy Duty: MSS Type 33.
  3. Horizontal Travelers: MSS Type 58.

4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
  5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.
  6. Anchor Bolts: Heavy duty, drilled-in concrete expansion wedge anchor bolts, Hilti or Red Head.
- G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
  2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
  3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Alternately Polyisocyanurate Urethane with a minimum flexural strength of 60psi, fully encased in 360 PVC (1.524 mm thick)SNAPPITZ. Provide assembly of same thickness as adjoining insulation.
  4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.
- H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
  2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
  3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
  4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
  5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

## 2.3 SEISMIC RESTRAINT/VIBRATION ISOLATION REQUIREMENTS

- A. Equipment, piping, and all system appurtenances (including weight of normal operating contents) shall be adequately restrained to resist seismic forces. Restraint devices shall be designed and selected to meet seismic requirements as defined in Chapter 16 of the latest edition of the UBC, with State Amendments, and applicable local codes in accordance with the local Seismic Zone and the applicable Importance Factors and Soil Factors.
- B. All anchorages and/or seismic restraints shall be designed by a registered professional Civil or Structural Engineer licensed in the state of the project. Design shall include:
1. Number, size and location of anchors for floor or roof-mounted equipment. For curb mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure.
  2. Number, size and location of vibration isolators, seismic restraint devices and their anchorage for vibration-isolated and suspended equipment.
  3. Number, size and location of braces and anchors for suspended piping and ductwork on shop drawings.
    - a. The contractor must select a single seismic restraint system pre-designed to meet the requirements of the current version of the IBC <<UBC>>, with State Amendments.

- b. Installations not addressed by the selected system must be designed, detailed and submitted along with the shop drawings.
  - c. Maximum seismic loads shall be indicated on drawings at each brace location.
  - d. Drawings shall bear the stamp and signature of the registered professional engineer licensed in the state of the project who designed the layout of the braces.
4. Manufacturers: Mason, M.W. Sausse, Kinetics or approved equal.
- C. Isolated Equipment:
- 1. Spring type isolators shall be freestanding and laterally stable and complete with 1/4" neoprene acoustical friction pads or neoprene cup between the spring and the base plate. All mountings shall have leveling bolts. 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. A steel housing shall be included to resist motion due to earthquake loads. A minimum clearance of 1/4" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. The housing shall be out of contact during normal operations. Mountings used out of doors shall be hot dipped galvanized. Manufacturer: Mason Industries #SLR series or approved equal.
  - 2. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad 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. Manufacturer: Mason Industries #SLF series or approved equal.
  - 3. Spring hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. 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. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Manufacturer: Mason Industries #30N or approved equal.
  - 4. All-directional seismic snubber restraints shall consist of interlocking steel members restrained by a one-piece molded bushing or bridge bearing neoprene. A minimum air gap of 1/4" shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end shall be removable to allow inspection of internal clearances. Manufacturer: Mason Industries #Z-1225.
  - 5. Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" clearance below the base. Manufacturer: Mason Industries #WF.

6. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows and shall be 6" deep for pumps thru 75 HP and 10" deep for pumps 100 HP thru 250HP. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Manufacturer: Mason Industries #BMK or K.
  7. Suspended isolated equipment and vessels shall be protected with cable restraints. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation, starting or stopping. Seismic sway braces shall consist of galvanized steel aircraft cables. Cables braces shall be designed to resist seismic tension loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Manufacturer: Mason Industries #SCB, SRC and UC.
  8. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Manufacturer: Mason Industries #SFDEJ, SFEJ, SFDCR, SFU and CR.
  9. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Hoses must have sufficient length to accept 1/2" intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Manufacturer: Mason Industries #BSS.
- D. Rigidly Mounted Equipment: Floor mounted equipment weighing over 400 lbs. and suspended equipment and vessels of any weight shall be protected by properly sized anchor bolts or hanger rods and bracing and, if required, by additional seismic restraints as described above for isolated equipment.

- E. All non-isolated piping and ductwork shall be protected in accordance with the SMACNA Guidelines. At the Contractor's option, for ease of installation, cable restraint system may be used. Installations not addressed in the SMACNA Guidelines shall be designed by a registered professional engineer who designed the seismic bracing for the suspended piping and ductwork.
- F. Isolator Types: Where equipment isolators are not provided by other sections of the specification or shown on Drawings, provide factory fabricated isolator types sized by the manufacturer for the appropriate loading. Model numbers of Mason Industries products are listed below. Products of other manufacturers will be acceptable provided they comply with all of the requirements of this specification and the Drawings. Manufacturers: Mason Industries, M.W. Sausse, Kinetics or approved equal.
  - 1. Floor Mounted Pumps: 2" free-standing type housed single coil spring with separate seismic snubbers. Mount on concrete filled inertia base with weight not less than that equaling the equipment weight. Mason Industries #BMK base with #SLF springs and #Z-1225 snubbers.
- G. Submittals:
  - 1. Confirmation of responsible design party (Shop Drawings received without this information will be rejected without review. Architect will be informed of potential delay of project.)
    - a. The seismic manufacturer's representative or engineer responsible for preparing the specified seismic submittal package shall send the following documentation of qualification:
      - 1) The name and professional engineer's license number of the structural engineer who will be responsible for preparing, designing, and stamping the seismic shop drawing information.
  - 2. Shop Drawings submittal
    - a. Stamped seismic restraint calculations.
    - b. The type, size and deflection of each isolator proposed.
    - c. Details for all the isolators with snubbers proposed and seismic bracing.
    - d. Details for steel frames to be used in conjunction with the isolation and seismic restraint of the items.
    - e. Clearly outlined procedures for installing and adjusting the isolators, seismic restraints and snubbers.

## 2.4 PIPE PORTALS

- A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.
- B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
  - 1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
  - 2. Insulation to be 1-½" thick, 3 lb density rigid fiberglass.
  - 3. Curb to have a raised 3" (minimum), 45° cant.
  - 4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
  - 5. Curb height to be 8" (minimum) above roof deck.
  - 6. Cant shall be raised to match roof insulation thickness.

7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
8. Manufacturer: Roof Products Systems or Pate.

## 2.5 EQUIPMENT/PIPING RAILS

- A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.
- B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
  1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
  2. Provide internal reinforcing supports welded as required to meet application requirements.
  3. Equipment rails to have raised 3" (minimum), 45° cant.
  4. Equipment rails to have 1 1/2" x 1 1/2" wood nailer (minimum) and counterflashing.
  5. Equipment rail height to be 6" (minimum) above roof deck.
  6. Cant shall be raised to match roof insulation thickness.
- C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.
- D. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

## 2.6 ACCESS PANELS AND ACCESS DOORS

- A. Layout system to avoid access doors or panels.
- B. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.
- C. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
- D. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.
- E. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

## 2.7 IDENTIFICATION MARKERS

- A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 22 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.
- B. Plastic Pipe Markers:
  - 1. Snap-On Type: Provide pre-printed, semi-rigid snap-on, color coded pipe markers, complying with ANSI A13.1.
  - 2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
  - 3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
  - 4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
- C. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.
- D. Valve Tags:
  - 1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
  - 2. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
  - 3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
  - 4. Access Panel Markers: Provide 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.
  - 5. Non-potable Water Tags: 1/16" thick, engraved, plastic tags as indicated on Drawings.
- E. Plastic Equipment Signs:
  - 1. Provide 4-1/2" x 6" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
  - 2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
  - 3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
    - a. Name and plan number.
    - b. Equipment service.
    - c. Design capacity.
    - d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.
- F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

## 2.8 ELECTRICAL

### A. General:

1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

### B. Quality Assurance:

1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

### C. Motors:

1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.
4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
  - a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
  - b. VFD driven motors. To be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device or as an insulated bearing motor.
  - c. Bearings:
    - 1) Ball or roller bearings with inner and outer shaft seals.
    - 2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
    - 3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
    - 4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
    - 5) Enclosure Type:
      - a) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      - b) Guarded drip-proof motors where exposed to contact by employees or building occupants.
      - c) Weather protected Type I for outdoor use, Type II where not



- housed.
  - d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
  - e. Noise Rating: "Quiet."
  - f. Efficiency:
    - 1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
    - 2) Motors shall meet the NEMA premium efficiency standard
  - g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
- D. Starters and Electrical Devices:
- 1. Motor Starter Characteristics:
    - a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
    - b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
  - 2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
  - 3. Magnetic Starters:
    - a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
    - b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
    - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
    - d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
    - e. Externally operated manual reset.
    - f. Under-voltage release or protection for all motors over 20 hp.
  - 4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.
- E. Low Voltage Control Wiring:
- 1. General: 14 gauge, Type THHN, color coded, installed in conduit.
  - 2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.
- F. Disconnect Switches:
- 1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
  - 2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
- B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

### 3.2 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

### 3.3 INSTALLATION

- A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost.
- B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

### 3.4 SUPPORTS AND HANGERS

- A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.
- B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.
- C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

- D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- G. Support gas independently of other piping.
- H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- I. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

1. Steel Pipe (Water Filled):

<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 1 1/4"	5 feet	3/8"
1 1/2" to 2"	7 feet	3/8"
2 1/2" to 3"	10 feet	1/2"
4" and larger	12 feet	5/8"

2. Steel Pipe (Gas/Air Filled):

<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 1 1/4"	6 feet	3/8"
1 1/2" and larger	10 feet	1/2"

3. Copper Pipe:

<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	6 feet	3/8"
2 1/2" and larger	8 feet	1/2"

4. Glass Pipe:

<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	6 feet	3/8"
2 1/2" and larger	8 feet	1/2"

5. Plastic/Fiberglass Pipe:

<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	4 feet	3/8"
2 1/2" and larger	6 feet	1/2"

- 6. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.

J. Sloping, Air Venting, and Draining:

1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

<u>Service</u>	<u>Inclination</u>	<u>Slope</u>
Domestic Water	Down	1" per 100'
Heating Water	Up	1" per 40'
Steam	Down	1" per 40'
Soil and Waste	Down	1/4" per foot (1/8" per foot)
Storm Water	Down	1/4" per foot (1/8" per foot)
Sanitary Vent	Up (towards roof terminal)	1/4" per foot (1/8" per foot)

2. Slope all compressed air branch piping down toward main risers at 1" per 10'.
3. Provide eccentric reducers in horizontal piping for all sizing changes:
  - a. <<Steam piping-bottom side flat. >>
4. <<Connect steam supply branch piping to the top of mains. >>
5. Provide drain valves and hose adapters at all low points in piping.
6. Provide vents at all high points in water piping.

K. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
  - a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
  - b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
  - c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:

1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Equipment Supports:

1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

- N. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
  2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
  3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

- A. Install per manufacturer's instructions.
- B. Coordinate with other trades so units are installed when roofing is being installed.
- C. Verify roof insulation thickness and adjust raise of cant to match.

3.6 VIBRATION CONTROL ISOLATORS

- A. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
- B. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
- C. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- D. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
- E. Flexible Pipe Connectors: Install on equipment side of shutoff valves.
- F. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.7 ELECTRICAL REQUIREMENTS

- A. Plumbing Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.
- B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all plumbing, motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Plumbing Division of these Specifications.

- C. Division 22 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 22 Specifications or scheduled on Division 22 Drawings. The specific division of responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:
1. Division 22 Plumbing Responsibilities:
    - a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
    - b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 22 equipment, also furnish and install the power wiring between starter and motor.
    - c. VARIABLE FREQUENCY DRIVES: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
    - d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 22 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
    - e. CONTROLS: Division 22 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      - 1) Control relays necessary for controlling Division 22 equipment.
      - 2) Control transformers necessary for providing power to controls for Division 22 equipment.
      - 3) Low or non-load voltage control components.
      - 4) Non-life safety related valve.
      - 5) Float switches.
      - 6) Solenoid valves, EP and PE switches.
- D. Division 26 has responsibilities for electrically powered or controlled equipment which is specified in Division 22 Specifications or scheduled on Division 21 Drawings. The specific division of responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:
1. Division 26 Electrical Responsibilities:
    - a. MOTORS: Provide the power wiring for the motors.
    - b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 22 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 22 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
    - c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD's, which are not specified to be installed on Division 22 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 22. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.
    - d. DISCONNECTS: Provide all disconnects necessary for Division 22 mechanical equipment which are not provided as part of factory wired Division 22 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
    - e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.

2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
  3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
  4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
  5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
  6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

### 3.8 PAINTING

- A. All painting shall be provided under this Division work, unless otherwise specified under Division 09: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.
- B. All exposed work under Division 22 shall receive either a factory finish or a field prime coat finish, except:
1. Exposed copper piping.
  2. Aluminum jacketed outdoor insulated piping.

### 3.9 IDENTIFICATION MARKERS

- A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Piping System Identification:
1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
  2. Locate pipe markers as follows:
    - a. Near each valve and control device.
    - b. Near each branch, excluding short take-offs for fixtures; mark each pipe at branch, where there could be question of flow pattern.

- c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
  - d. At access doors, manholes, and similar access points which permit view of concealed piping.
  - e. Near major equipment items and other points of origination and termination.
  - f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.
- C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.
- D. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
  - 1. Main control and operating valves, including safety devices.
  - 2. Meters, gauges, thermometers, and similar units.
  - 3. Pumps, compressors and similar motor-driven units.
  - 4. Hot water system mixing valves and similar equipment.
  - 5. Boilers, heat exchangers and similar equipment.
  - 6. Tanks and pressure vessels.
  - 7. Strainers, filters, treatment systems and similar equipment.
- E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.
- F. Gas pressure regulators shall have metal tags attached stating, "Warning: <<2>> lbs. upstream natural gas pressure. Do not remove."

### 3.10 VIBRATION AND DYNAMIC BALANCING

- A. Vibration tolerances shall be as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
  - 1. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
  - 2. Compressors: Same as pumps.
- B. Correction shall be made to all equipment which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

### 3.11 TESTING

- A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

END OF SECTION



SECTION 22 05 01 - PLUMBING

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Materials and Methods
- B. Section 230700: Plumbing Insulation
- C. Section 222113: Plumbing Piping, Valves and Specialties
- D. Section 224000: Plumbing Fixtures

1.3 SCOPE

- A. All work includes providing new plumbing. Systems as specified under this section shall include but not necessarily be limited to the following:
  - 1. Connection to utilities at five (5) feet from the building. Coordinate with the Civil Engineering Plans and/or Division 02 work.
  - 2. Connection of all waste, vent, and water piping to all plumbing fixtures, drinking fountains, sinks, electric water coolers, drains and mechanical equipment.
  - 3. Provide for future expansion as indicated.
  - 4. Connect to new mechanical equipment including chiller, cooling tower expansion tanks, domestic hot water heaters, and boilers, etc.
  - 5. Connect or cold water to hose bibbs and wall hydrants. Provide reduced pressure type backflow preventor assembly on connection to chillers expansion tanks, and cooling towers as indicated.
  - 6. Provide traps on all floor drains with trap primer where specified. Pipe to trap shall be ½" minimum.
  - 7. Provide domestic hot water recirculation system. Provide floor drainage in, mechanical rooms and equipment rooms.
  - 8. Provide connections for all area drains, downspouts, roof drains and overflow drains to storm sewer system.
  - 9. Contractor to start gas system at discharge flange of meter setting assembly. Provide regulator assembly to reduce pressure to 2.0 psi maximum entering building.
  - 10. Provide gas shut-off and regulator assembly at each connection, as detailed on drawings. Supply to any piece of equipment shall not exceed 0.5 psi.
  - 11. Temporary Water Service: As directed by the General Contractor, the plumber shall provide a temporary metered water service and temporary water risers with four (4) hose bibbs installed at each level as the building proceeds upwards to the roof.

#### 1.4 SUBMITTALS

- A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
  - 1. Plumbing specialties.
  - 2. Trap primers.
  - 3. Cleanouts.
  - 4. Drains
  - 5. Roof flashing
  - 6. Wall hydrants and hose bibbs

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

#### 1.6 WARRANTY

- A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. All materials and equipment under this Division of the Specifications shall be new, of best grade and as listed in printed catalogs of the manufacturer.
- B. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.
- C. <All items shall be furnished Vandal Proofed. One type of vandal proof screw is to be used through out this facility. Coordinate with general contractor for type.>
- D. The following products to be included as part of this work but specified under Section 220500 Basic Materials and Methods and Section 222113 Plumbing Piping, Valves and Specialties:
  - 1. Piping.
  - 2. Valves.
  - 3. Hangers and supports.
  - 4. Escutcheon plates, flashings, and sleeves.
  - 5. Identification markers and signs.
  - 6. Anchors, alignment guides and Seismic Zone 3 requirements.
  - 7. Excavation and backfill.
  - 8. Pressure and temperature gauges.
  - 9. Access Panels.

- E. Plumbing Fixtures: Refer to Section 224000.
  - F. Products made of, or containing, lead, asbestos, mercury, or other known toxic or hazardous materials are not acceptable for installation under this Section. Any such products installed as part of the work of this Section shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
- 2.2 VALVES: DOMESTIC WATER AND NATURAL GAS (See Section 222113)
- 2.3 CLEANOUTS
- A. Cleanout Plugs: Bronze, taper thread countersunk head.
  - B. Floor Cleanouts: Service weight cast-iron body and frame, flange with flashing clamp, adjustable cast-iron collar, caulk inside, Ty-seal or No-hub joints, neoprene plug gasket seal.
    - 1. Carpeted Areas: Zurn ZN-1400-KC-VP-BP-CM or J. R. Smith 4028 C - F - C - Y - U
    - 2. Tiled Areas: Zurn ZN-1400-X-KC-VP-BP or J.R. Smith 4148 - F - C - U
    - 3. Unfinished Areas: Zurn ZN-1400-HD-KC-VP-BP or J.R. Smith 4108 C - F - C - U
    - 4. Yard Areas: Zurn Z 1474-IN-VP or J.R. Smith 4258 - C - U
  - C. Cleanout Tee: Cast iron cleanout tee with countersunk brass plug, neoprene plug gasket seal and smooth stainless steel cover.
    - 1. Manufacturer: Zurn Z-1446-BP or J. R. Smith 4532 S (Y)
- 2.4 ROOF FLASHING
- A. Flashing: Unless indicated otherwise on the drawings flashings for pipes through the roof shall be galvanized sheet metal, 24 gauge minimum with seams and joints lapped and soldered watertight. Coordinate with Architectural Sections for flashings and roofing.
  - B. Vent Pipes: Provide caulk type, vandalproof hood with Allen head vandal proof screws for all vent pipes through roof or preformed vinyl/galvanized steel assembly.
- 2.5 WATER HAMMER ARRESTORS
- A. Piston Type: Hard drawn copper construction, mirror finished internal surfaces; machine finished brass piston, air charged, 250 psi rated, tested and certified per PDI WH-201 and ASSE 1015. Coordinate location of access panels with Architect or provide access panel where none are shown.
    - 1. Manufacturer: Watts Series 15, Precision Plumbing series SC, or Sioux Chief.
- 2.6 HOSE BIBBS (see plumbing schedule)
- 2.7 DRAINS
- A. General: Provide drains of type and size as indicated on drawings, including features, as specified herein.
    - 1. Acceptable Manufacturers: J.R. Smith, Zurn, Wade, Sioux Chief, Josam and Watts.
  - B. Outlet.

## 2.8 TRAP PRIMER

- A. Cast bronze construction, vacuum breaker, ½" sweat solder connection. Install in accessible location or provide access panel.
  - 1. Manufacturer: PPP Oregon #1 or E&S, for use for up to 8 drains using PPP trap primer distribution units.
  - 2. Manufacturer: PPP Prime-Pro flow activated trap primer <<PR01-500>>.
  - 3. Option: Sloan F-72-A1 used in conjunction with water closet flush valve.
- B. For Multiple Units or Kitchen Areas: PPP Prime Time electronic trap primer Series PT. Coordinate 120 V, electrical service with Division 26.
- C. Contractor to install water hammer arrester and trap primer behind same access door where possible.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. This system to be installed by an experienced firm regularly engaged in the installation of plumbing systems as specified by the requirements of the Specifications.
- B. Install all items specified in this section of the Specification under the full purview of local and state governing agencies.
- C. Refer to Section 220500: General Plumbing Requirements for installation of piping, valves and other requirements.

### 3.2 PERFORMANCE OF WORK

- A. Examine areas, physical conditions and phasing requirements under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings.
- B. Work shall start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed. No foundry items to be installed until submittals have been approved.
- C. Coordinate with other trades as necessary to properly interface components of the plumbing system.
- D. Follow manufacturer's directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the drawings or covered in these Specifications.
- E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

### 3.3 PIPING INSTALLATION

- A. The word "piping" shall mean all pipes, fittings, nipples, valves and all accessories connected thereto.
- B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts flues, conduits and work of other trades and close to ceiling or other construction as practical, free of unnecessary traps or bends.
- C. Run horizontal sanitary drainage at uniform pitch of not less than 1/8" per foot, unless otherwise indicated. Pitch horizontal vent piping downward from stack to fixtures.
- D. Run drainage piping as straight as possible with long radius turns. Offsets shall be made at an angle of 45° or less.
- E. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.
- F. Piping connections to all equipment shall be made up with unions.
- G. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.
- H. Use reducers or increasers. Use no bushings.
- I. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageway.
- J. Vent pipes to terminate at least 6" above the roof. Provide vandal proof hood assembly.
- K. Cover, cap or otherwise protect open ends of all piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect water supply piping as specified.
- L. Exposed connections to equipment shall be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bend piping to be permitted.
- M. All ferrous to non-ferrous connections shall be made by means of dielectric fittings. Submit shop drawings for approval.
- N. Use extra heavy pipe for nipples, where unthreaded portion is less than 1½". Use no close nipples. Use only shoulder nipples.
- O. All piping shall be inspected for defects and flaws prior to installation. Remove any damaged piping from job site. Piping shall be thoroughly cleaned of dirt, debris or rust.
- P. Cleanouts to be provided at each change in direction greater than 135° or 100' maximum intervals on underground piping.
- Q. <<Revise existing cleanout elevations to be flush with new floor elevation. >>
- R. Cleanouts to be same size as pipe except cleanout plugs larger than 4" shall not be required.

- S. Cleanouts on concealed piping to be extended through and terminate flush with the finished wall or floor. Cover plates to be provided on all cleanout plugs in finished areas.
- T. The bodies of cleanout ferrules to conform in thickness to that required for pipe and fittings of the same metal.
- U. Route piping on roof on manufactured polypropylene pipe supports: Roof Top Blox RTB-#.

### 3.4 WATER HAMMER ARRESTERS

- A. Install as per PDI Standard WH-20 and equipment manufacturer's recommendation and as shown on working drawings. Provide before each quick closing valve (flush valve, solenoid valve, etc.) or bank of fixtures.
- B. Install at each plumbing fixture, bank of fixtures, equipment and as indicated.

### 3.5 TESTING AND DISINFECTING - PLUMBING SYSTEMS

- A. General: The Contractor to perform all field tests and provide all labor, equipment, and incidentals required for the tests. Owner to witness all field tests and conduct all field inspections. The Contractor to give the Owner ample notice of the dates and times scheduled for tests. Any deficiencies to be completely retested at no additional cost.
  - 1. Inspection: Inspection to continue during installation and testing. Perform a final inspection of the equipment prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. Correct or replace all rejected equipment prior to installation.
  - 2. Water Distribution Piping Test: Before fixtures are set, subject the entire hot and cold piping system to a hydrostatic pressure test of 150 pounds per square inch with water for not less than 8 hours in order to permit inspection of all joints with no evidence of leakage. Where a portion of the water distribution piping is to be concealed before completion, test this portion separately as specified for the entire system.
  - 3. Sanitary, Waste, Storm, Rainwater, and Vent Piping Test: Before the installation of any fixtures or drains, cap the ends of the system and fill all lines with water to the roof level and allow to stand for at least 30 minutes without leakage. Make tests within building with piping exposed. If the system is tested in sections, tightly lug each opening, except the highest opening of the section under test, and fill each section with water and test with at least a 10' head of water.
  - 4. Sanitary Drainage Vent, Storm, Rainwater and Fixture System Final Test: Give sanitary, drainage vent, and fixture systems an in-service test after complete installation. After all fixtures are installed, test the entire vent and sewer system and prove gas and water tight. Final test shall be with air. Before proceeding with test, fill all traps with water. Close all stacks and line openings during test, for a minimum period of 24 hours. If test reveals leakage of air at any point, repair and retest the system.
  - 5. Disinfection of Water Distribution System: After pressure tests have been made thoroughly flush the entire domestic water distribution system with water until all entrained dirt and mud have been removed, and sterilize by chlorinating material. The chlorinating material shall be liquid chlorine. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system or part thereof in an approved manner. Retain the treated water in the pipe for 24 hours, or, fill the system or part thereof with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for three hours. Open and close all valves in the system being disinfected three times during the contact period.

Then flush the system with clean potable water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period open and close all valves and faucets three times. From at least three divergent points in the system, take samples of water in properly sterilized containers for bacterial examination. Repeat the disinfecting until tests indicate that satisfactory bacteriological results have been obtained.

- a. Taking of samples shall be witnessed by Architect or Owner's representative. Samples are to be taken and tested by an independent analytical testing laboratory. Written reports shall be supplied to Architect for approval.

### 3.6 OPERATING TESTING AND CERTIFICATION - PLUMBING SYSTEMS

- A. Upon completion and disinfection, and prior to acceptance of the installation, the Contractor to subject the plumbing system to operating tests to demonstrate satisfactory, functional, and operating efficiency. Such operating tests to include the following information in a report with conclusions as to the adequacy of the system.
  1. Time, date, and duration of tests.
  2. Water pressures at most remote location.
  3. Operation of all valves and hydrants.
  4. Operation of all floor drains by flooding with water.
  5. Quality of domestic water.
  6. Read all indicating instruments at half-hour intervals unless otherwise directed. Supply four copies of the test report to the Owner.

### 3.7 CLEANING EQUIPMENT AND MATERIALS

- A. In addition to the requirements of Section 220500, provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care to be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors, and similar equipment.
- B. All piping, finished surfaces, and equipment to have all grease, adhesive labels, and foreign materials removed.
- C. All piping to be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation for ten days.
- D. When connections are to be made to existing systems, the Contractor is to do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

### 3.8 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

- A. General: Refer to Section 220500 for details.

END OF SECTION

## SECTION 22 07 00 - PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
  - 1. Piping:
    - a. Domestic hot water supply and return.
    - b. Horizontal roof and overflow drain piping.
    - c. Underground water piping.
    - d. Drains from electric water coolers to first connection.
    - e. Horizontal pipe runs from fixtures receiving cold condensate.
    - f. All valves, separators, strainers and fittings for systems listed above.
  - 2. Drains:
    - a. All roof and overflow drain bodies.
- B. Types of mechanical insulation specified in this Section include the following:
  - 1. Fiberglass pipe insulation.
  - 2. Cellular glass pipe insulation.
  - 3. Calcium silicate pipe insulation.
  - 4. Flexible elastomeric closed cell insulation
  - 5. Fiberglass equipment insulation.
  - 6. Calcium silicate equipment insulation.
  - 7. Cellular glass equipment insulation.
  - 8. Flexible unicellular equipment insulation.
  - 9. Insulation jackets.
  - 10. Insulation accessories.

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Materials and Methods.
- B. Section 220501: Plumbing.

#### 1.4 DEFINITIONS

- A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.
- B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
- C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.



- D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
- E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
- F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
- G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
- H. ASHRAE fundamentals under 99% column for winter design conditions.

## 1.5 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
  - 1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
    - a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    - b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
    - c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
    - d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
    - e. Properties by Means of the Guarded-Hot-Plate Apparatus.
    - f. C195 - Specification for Mineral Fiber Thermal Insulating Cement.
    - g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
    - h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
    - i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
    - j. C305 - Test for Thermal Conductivity of Pipe Insulation.
    - k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
    - l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
    - m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
    - n. C449 - Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - o. C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
    - p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
    - q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    - r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
    - s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
    - t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
    - u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
    - v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.

- w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
  - x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
  - y. C1104 – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
  - z. C1071 - Standard Specification for Thermal and Acoustical Insulation.
  - aa. C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings..
  - bb. E84 - Test Method for Surface Burning Characteristics of Building Materials.
  - cc. E119 - Test for Fire Resistance.
  - dd. G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
  - ee. G22 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
- 2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
    - a. 90 Energy Conservation in New Building Design.
  - 3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
    - a. 255 Test Methods, Surface Burning Characteristics of Building Materials.
- B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.
- C. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- D. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
- 1. Test Specimen: Two specimens shall be used, each measuring 1" by 4" by approximately ½" thick.
  - 2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1" wide, 4" long and 0.020" thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
  - 3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.
- E. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

## 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.
- B. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
  - 1. Pentabrominated diphenyl ether (CAS#32534-81-9)
  - 2. Octabrominated diphenyl ether (CAS#32536-52-0)
  - 3. Decabrominated diphenyl ether (CAS#1163-19-50)
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
- B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

### 2.2 PIPE INSULATIONS

- A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
  - 1. Manufacturers:
    - a. Johns Manville Micro-Lok plain with PVC cover Meeting ASTM C547; or Micro-Flex (pipe sizes larger than 18"), Knauf insulation.
  - 2. Applications: Insulation of piping up to 18" in diameter and 3" thick insulation.
  - 3. 'K' Value: 0.23 at 75°F.
  - 4. Maximum Service Temperature: 850°F.
  - 5. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.

- B. Rigid polyisocyanurate foam: HiTHERM HT-300.
1. 'K' Value: 0.165 at 75°F (24°C)
  2. Maximum Continuous Service Temperature: 300°F.
  3. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.
- C. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold, ASTM C533; Rigid Molded Pipe:
1. 'K' Value: 0.40 at 300°F.
  2. Maximum Service Temperature: 1,200°F.
  3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
  4. Tie Wire: 16 gauge stainless steel with twisted ends on maximum 12" centers.
- D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
  2. Density: 8.0 lbs./cu. ft.
  3. Maximum Service Temperature: 900°F.
  4. Provide with Pittsburg Corning Pittwrap jacketing.
- E. Flexible Elastomeric Closed Cell Thermal Insulation: Armacel, Rubatex k-flex ECO, closed-cell, halogen free, elastomeric insulation. Comply with ASTM-C177, ASTM E 84 and UL 181.
1. 'K' Value: 0.27 at 75°F.
  2. Density: 3.0 to 6.0 lbs./cu.ft.
  3. Maximum Service Temperature: 260°F.
  4. Seal all seams and joints with contact adhesive.
- F. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
  2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
  3. Canvas Jacket: UL listed fabric, 6 oz/sq. yd. plain weave cotton, treated with dilute fire retardant lagging adhesive.
  4. Aluminum Jacket: 0.016" thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
  5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.
- G. Field Applied Jackets (For Exterior Applications):
1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
  2. Aluminum Jacket: 0.016" (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
  3. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
  4. Secure stainless steel or aluminum jackets with ¾" or ½" stainless steel bands on 12" centers.
  5. Manufacturers: Pabco, Childers, RPR, or approved equal.

H. Removable Covers:

1. Provide removable covers on pumps, valves, air separators, vents, fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation may be required.
2. Use of premolded fittings with PVC covers is acceptable.
3. Use of lace-on type insulating blankets is acceptable.

2.3 EQUIPMENT INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:

1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F installed full thickness.
2. Maximum Service Temperature: 250°F.
3. Density: 0.75 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Rigid Fiberglass Board: Johns Manville Mat-Faced Micro-Aire Rigid Board:

1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
2. Maximum Service Temperature: 250°F.
3. Density: 3.0 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
5. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

C. Rigid Fiberglass Board: Johns Manville 1000 Spin-Glas Meeting ASTM C612; Rigid, Noncombustible:

1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
2. Maximum Service Temperature: 850°F.
3. Density: 3.0 lb/cu ft.
4. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:

1. 'K' Value: 0.35 at 75°F.
2. Density: 8.0 lb/cu. ft.
3. Maximum Service Temperature: 900°F.

E. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:

1. 'K' Value: 0.40 at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1½" thickness.
4. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12" maximum centers for large areas.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION AND PREPARATION

- A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.
- B. Verify that all surfaces are clean, dry and free of foreign material.

#### 3.2 INSTALLATION

- A. General:
  - 1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
  - 2. Remove and replace any insulation that has become wet or damaged during the construction process.
  - 3. Continue insulation and vapor barrier at penetrations and supports, except where prohibited by code.
- B. Piping Insulation:
  - 1. Locate insulation and cover seams in least visible locations unless otherwise specified.
  - 2. Neatly finish insulation at supports, protrusions, and interruptions.
  - 3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
  - 4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
  - 5. Provide insert between support shield and piping on piping 1½" diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
    - a. 1½" to 2½" pipe size 10" long
    - b. 3" to 6" pipe size 12" long
    - c. 8" to 10" pipe size 16" long
    - d. 12" and over 22" long
  - 6. Use of metal saddles is acceptable as specified in Section 15050. Fill interior voids with segments of insulation matching adjoining pipe insulation.
  - 7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
  - 8. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.
  - 9. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.

10. For exterior applications:
    - a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
    - b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.
  11. For underground installations, install per manufacturer's written instructions and recommendations.
  12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.
- C. Equipment Insulation:
1. See Piping Insulation above for additional requirements.
  2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer's recommendations.
  3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
  4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
  5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
  6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
  7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
  8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
  9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

### 3.3 PIPING INSULATION SCHEDULE

- A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness  $\frac{1}{2}$ " if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

B. Fiberglass Insulation

	PIPE SIZE (inches)	THICKNESS (inches)
Domestic hot water	Up to 2 2 ½ and over	1 1 ½
Domestic hot water return	All Sizes	1
Roof and overflow drain bodies	All Sizes	1
Horizontal roof and overflow drainage	Up to 2 2 ½ and over	1 1

C. Elastometric Foam (Closed Cell):

	PIPE SIZE (inches)	THICKNESS (inches)
Condensate drain pipes	All Sizes	1/2

D. Cellular Glass:

	PIPE SIZE (inches)	THICKNESS (inches)
Underground hot water and cold water piping	Up to 2 2 ½ and over	2 2

END OF SECTION



## SECTION 22 08 00 – COMMISSIONING OF DOMESTIC HOT WATER SYSTEMS

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this Section, as if repeated herein.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 019113, General Commissioning Requirements
- B. Division 22 Sections pertaining to Domestic Hot Water Systems:
  - 1. 22 05 00 – Basic Materials & Methods with Seismic
  - 2. 22 05 01 – Plumbing
  - 3. 22 11 23 – Plumbing Equipment

#### 1.03 REFERENCES

- A. USGBC:
  - 1. LEED – NC 3.0: EA Prerequisite 1, Fundamental Commissioning.
  - 2. LEED – NC 3.0: Credit 3, Enhanced Commissioning.

#### 1.04 DEFINITIONS

- A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.
- B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, DHW and lighting systems.
- C. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professional(s) or the Contractor. The CxA assists the Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.
- D. Commissioning Issue (Cx Issues): A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.
- E. Commissioning Issues List (Cx Issues List): A log maintained by the CxA listing all Deficiencies and Cx Issues documented during the commissioning process. All issues require action, correction and closure.
- F. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail.
- G. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.
- H. Commissioning Coordinator (CxC): Individual within the General Contractor firm who plans, schedules, directs and coordinates all the Trade Sub-Contractor's commissioning activities, and serves as the CxA's single point of contact for all administrative, documentation and coordination functions.
- I. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.

- J. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents. A Deficiency will be considered a Cx Issue and documented on the Cx Issues List.
- K. Functional Performance Test (FPT): A test of the dynamic function, operation and control sequences of equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, alarm, power failure, etc. The FPTs are performed using manual (direct observation) or monitoring methods.
- L. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components prior to Startup. IV process is complete when systems are ready for Startup. IV's are organized and documented under the System Readiness Checklist (SRC) forms.
- M. Monitoring: The recording of parameters (flow, current, status, pressure, etc) of equipment operation shall be completed using data-loggers or the Trending capabilities of BAS or control systems.
- N. Owner's Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.
- O. Percent Sampling: Witnessing the startup or testing of a selected fraction of the total number of identical or near-identical pieces of equipment such as VAV boxes.
- P. Pre-Functional Checks & Tests (PFC): These are various checks and tests performed on a piece of equipment or system just before, during or after the initial Startup and operation. They are performed to confirm that the equipment and individual components were installed correctly and are working properly. Examples include checking fan rotation, sensor calibration, actuator testing, and spot temperature, pressure and electrical measurements. They also include system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system test and balance and electrical equipment NETA testing. They are organized under the System Readiness Checklist (SRC) forms and must be completed prior to FPTs.
- Q. Startup: Initial starting or activating of equipment usually performed by the Trade Sub-Contractor or the Manufacturer's authorized representative.
- R. System Readiness Checklist (SRC): A summary checklist, typically one page per equipment, covering the necessary commissioning tasks and required documentation to verify that a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFC, and the Trade Sub-Contractor completed forms for these tasks are attached to the equipment specific SRC. The SRC must be completed and signed by the General Contractor prior to conducting the FPTs.
- S. Trade Sub-Contractor: Typically a subcontractor to the General Contractor who provides and installs specific building components and systems and/or provides certain services.
- T. Trending: Monitoring using the Building Automation System (BAS) or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

#### 1.05 DESCRIPTION OF WORK

- A. Systems and equipment to be commissioned:
  - 1. Domestic hot water systems (not including any local fixtures)
- B. The work includes the completion and documentation of formal commissioning procedures by the General Contractor and Trade Sub-Contractors.

1. Commissioning (Cx) is defined as the process of verifying and documenting the installation and performance of selected building systems to meet the specified design criteria and contract documents, thereby satisfying the design intent and the Owner's requirements and operational needs.
2. The Design Professionals, General Contractor and Trade Sub-Contractors will provide the quality control for the design, installation, startup and checkout of the systems. The commissioning process provides review and qualitative functional testing in order to formally observe and document that the quality control efforts are successfully completed.
3. Refer to Section 019113, General Commissioning Requirements for summary description of the general commissioning process and requirements.
4. The Trade Sub-Contractors and the factory authorized service representatives shall be responsible for participation in the commissioning process as outlined in this specification and Section 019113 General Commissioning Requirements, and as directed by the General Contractor's Commissioning Coordinator (CxC) as overseen by the Commissioning Authority (CxA).

1.06 COMMISSIONING PROCESS

A. Submittal Review by the CxA

1. The CxA will review the Trade Sub-Contractor's submittals for the appropriate systems in the commissioning scope, concurrently with the Design Team and will provide review comments to the Design Team.
2. The General Contractor shall provide a submittal log to the CxA for referencing requested submittals to be reviewed by the CxA (for which the General Contractor shall issue to the CxA concurrently with the submission to the Design Professionals). Alternatively, the General Contractor shall include the CxA on the distribution of all Trade Sub-Contractor submittals issued to the Design Professionals, for systems applicable to this specification.
3. The General Contractor shall ensure that the requested submittals for review by the CxA are issued to the CxA at the same time they are issued to the Design Team.
4. Information from the submittals will also be used by the CxA to develop commissioning forms and test procedures.

B. Cx Plan and Form Development

1. The CxA prepares a Preliminary Cx Plan during the project final design phase. The Cx Plan provides guidance in the execution of the commissioning process during construction.
2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the commissioning process and systems are reviewed. The Preliminary Cx Plan is presented and specific requirements and responsibilities are discussed and implemented.
3. The CxA develops the SRC forms which list and track the completion of the Installation Verification, Startup, and Pre-Functional Checks & Tests required for each system and equipment to be commissioned. The SRC forms are provided to the General Contractor and Trade Sub-Contractors for review and comment.
4. The CxC shall submit to the CxA, for review and approval, representative blank forms for completing Installation Verification, Startup, and Pre-Functional Checks & Tests.

- a. Installation Verification forms are used to provide field verification and documentation of proper installation of equipment and system prior to formal Startup. Where appropriate, these forms may be combined with the Startup and Pre-functional Check & Test forms. And where appropriate, these forms can be checklists taken from the Manufacturer's installation manual.
  - b. Startup and Pre-Functional Check forms primarily consist of Manufacturer and Trade Sub-Contractor startup and checkout sheets and shall be used where required and appropriate. Where applicable, these forms shall include checks of the equipment controls including sensors and control devices.
  - c. The Pre-Functional Test forms shall also include forms for recording results from system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system TAB, electrical equipment NETA testing, etc.
5. The CxA will develop FPT procedures and forms. These test procedures are provided to the General Contractor and Trade Sub-Contractors for review and comment.
  6. The CxA will update and finalize the Cx Plan with equipment specific documentation and SRC and FPT forms.

C. System Readiness Activities

1. Meetings will be conducted throughout construction with Commissioning Team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx Issues.
2. The Trade Sub-Contractors shall perform Installation Verification, Startup and Pre-Functional Check & Test activities, as part of the system readiness checks to verify that the system is ready for operation or functional testing. The Trade Sub-Contractors and the CxC shall document completion of these activities on the SRC forms and attach the completed Installation Verification, Startup, and Pre-Functional Check & Test forms to the SRC.
  - a. In general, Installation Verification should be completed prior to Startup, but where appropriate, they can be completed into one activity.
3. The CxA will perform various observation inspections during the installation phase and back-checks of the completed Installation Verification. The CxA will also witness a percent sampling of the Startups and Pre-Functional Checks & Tests, including TAB procedures.

D. Functional Testing

1. Functional Performance Tests (FPTs) are tests of the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests are used to verify that the sequences of operation are correctly implemented and that the design intent criteria and performance of the systems have been met.
2. The CxA will develop FPT forms that contain:
  - a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.
  - b. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
  - c. A section for recording actual system response, notes and comments.
  - d. Any definitions of control system trend data to be collected and provided to the CxA in electronic format for analysis and review.

3. Once the SRC forms are completed, the FPTs are executed by the Trade Sub-Contractors and a sample are witnessed by the CxA, as defined in the Cx Plan. The FPTs may be achieved by any combination of manual testing, monitoring or trending.
4. Any deferred testing will be defined in the Cx Plan.

E. Deficiencies and Commissioning Issues

1. Throughout the process, the Commissioning Issues are recorded by the CxA on the Commissioning Issues List and distributed to the commissioning team. The General Contractor and Trade Sub-Contractors shall correct Commissioning Issues and retest the system(s), where applicable, without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and make all amendments to the issues list.

F. O&M Manuals, Training Verification and Final Documentation

1. The General Contractor shall compile and complete the Operations & Maintenance (O&M) Manuals provided by the Trade Sub-Contractors, per the contract documents requirements. The CxA will verify that the O&M manuals have been delivered to the Owner per the contract requirements and may request electronic copies of the O&M Manuals to aid in the completion of the Systems Manual.
2. The General Contractor shall submit a training schedule and specific training agendas provided by the Trade Sub-Contractors for each training class, to the CxA and Owner for review prior to conducting any training. The CxA will review and provide comment to the Owner and General Contractor on the specified training agendas. The CxA will verify completion of the training by receiving a copy of the training sign-in sheets, provided by the General Contractor.
3. The CxA will develop the Systems Manual (for energy-related systems per LEED requirements) with assistance from the General Contractor and Trade Sub-Contractors. The systems to be included are the HVAC systems and controls, lighting controls, domestic hot water systems and controls, and any renewable energy systems.
4. The CxA will complete the Final Construction Phase Commissioning Report and documentation for the Owner with assistance from the General Contractor and Trade Sub-Contractors.

G. Post-Occupancy Warranty Phase Commissioning

1. No later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.
2. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period.

1.07 COMMISSIONING TEAM

- A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:
1. Owner and Owner's Representatives
  2. Design Professionals (DP)
  3. Commissioning Authority (CxA).

4. General Contractor
5. General Contractor's Commissioning Coordinator (CxC)
6. Trade Sub-Contractors responsible for systems covered in this section include:
  - a. Plumbing Contractor

#### 1.08 RESPONSIBILITIES

- A. General.
  1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.
- B. Commissioning Authority (CxA)
  1. See Section 019113, General Commissioning Requirements.
- C. General Contractor:
  1. See Section 019113, General Commissioning Requirements.
- D. Trade Sub-Contractors – General Requirements:
  1. Provide commissioning submittal data, including manufacturer's installation checks and startup procedures, commissioning forms, and any other requested contract documentation for systems to be commissioned. Electronic files are acceptable.
  2. Attend commissioning meetings as directed by the CxA and General Contractor's CxC to facilitate the commissioning process.
  3. Assign personnel with expertise and authority to act on behalf of the General Contractor and schedule them to participate in and perform assigned commissioning tasks.
  4. Demonstrate and document proper system installation, startup and performance. Complete all Installation Verification, Startup and Pre-Functional Check & Test documentation clearly and legibly. Provide a copy of all forms to the CxC and CxA as part of completing the SRC forms.
  5. Provide access for the CxA to witness any equipment Startup and Pre-Functional Checks & Tests. Notify the CxC and CxA at least 10 days in advance of Startup and Pre-Functional Checks & Tests.
  6. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.
  7. Ensure that any required manufacturer's representative field tests and on-site installation verification, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.
  8. Address Trade Sub-Contractor applicable Cx Issues and Deficiencies promptly. All Installation Verification, Startup and Pre-Functional issues must be resolved before the FPT can proceed.
  9. Assist CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.
  10. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits and overrides to be used during the tests.
  11. As part of the FPTs, the Trade Sub-Contractor shall setup any additional software points, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs. Perform the FPTs. Execution of FPTs shall be witnessed by the CxC and CxA and fully documented.

12. Perform the FPTs. Execution of FPTs shall be witnessed by the CxC and CxA and fully documented.
13. Prepare a training agenda for each training class (to be reviewed by the CxA) and work with the General Contractor and Owner to schedule training. Execute training of Owner's personnel per approved training agenda and schedule.
14. Prepare O&M Manuals according to the Contract Documents.
15. Assist the CxA in developing the Systems Manual.

E. Trade Sub-Contractors – Specific Plumbing System Requirements

1.09 SUBMITTAL REQUIREMENTS FOR COMMISSIONING

- A. The Trade Sub-Contractors shall submit to the CxA representative, blank forms for Installation Verification, Startup and Pre-Functional Checks & Tests.
  1. The CxA will review these submitted commissioning forms for completeness including any project specific requirements.
  2. The CxA may request additional data, changes and/or additions to these forms to make sure they are complete prior to their use. If the submitted forms are not available or are not sufficient, then the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.
- B. The Trade Sub-Contractors shall submit to the CxA any equipment and construction submittals and shop drawings, including detailed sequences of operation, as requested by the CxA.

PART 2 -PRODUCTS

2.01 DOCUMENTATION

- A. The Trade Sub-Contractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.
- B. The Trade Sub-Contractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc. , whether specified or not in the commissioning sections.

2.02 TEST EQUIPMENT

- A. The Trade Sub-Contractor shall provide all test equipment to execute Pre-Functional and Functional Performance Tests.
- B. The test equipment shall be provided in sufficient quantities to execute testing in an expedient fashion.
- C. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents. If not otherwise specified, the following minimum requirements apply:
  1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degree F and a resolution to + or – 0.1 degree F.
  2. Pressure sensors shall have an accuracy of + or – 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

- D. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.

### PART 3 - EXECUTION

#### 3.01 SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS

- A. All tests and start-up procedures shall be conducted without compromise to human or equipment safety. The General Contractor and Trade Sub- Contractors shall be responsible for the liability and safety of conducting all tests and startup.
- B. The General Contractor shall clearly identify and list any Deficiencies resulting from the Installation Verification, Start-up and Pre-Functional Checks & Tests on the associated forms and immediately notify the CxA. Once Deficiencies are corrected and verified or tested, update and resubmit the associated forms.
- C. The CxC and Trade Sub-Contractors shall a minimum 10 day's notice to the CxA for witnessing equipment Start-ups and Pre-Functional Checks & Tests.

#### 3.02 FUNCTIONAL PERFORMANCE TESTS

- A. Functional testing shall be performed and documented for 100% of all equipment in the scope of commissioning. At the discretion of the CxA and per the approved Cx Plan, the CxA may witness a percentage (sample) of the functional tests for selected, multiple identical pieces of non-life-safety or non-critical equipment (example: VAV boxes).
- B. The General Contractor and Trade Sub-Contractors shall be responsible for the liability and safety of conducting all tests.
- C. Ensure the following are completed prior to the start of the FPTs:
  - 1. Certify through the System Readiness Checklist (SRC) forms that the HVAC systems, controls and instrumentation, equipment and assemblies have been installed, calibrated, started and are operating per the Contract Documents. Approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.
  - 2. Where applicable, any BAS graphics and programming for the sequence of operations and associated setpoints, schedules, and alarms shall be configured and the system operation checked and confirmed, prior to starting functional testing.
- D. Trade Sub-Contractors shall execute all FPTs per the approved test procedures on the FPT forms. All testing results shall be documented on the final FPT forms; the forms shall be signed and dated by the representative performing the tests. Off hours or weekend work may be required to complete the FPTs.
- E. The CxC and Trade Sub-Contractors shall coordinate all FPT with the CxA, and provide a minimum of 10 day's notice prior to conducting each system test.
- F. FPT for each system must be successfully completed and signed by the CxA prior to formal approval of system commissioning.
- G. FPT may be conducted using these approved test methods:
  - 1. Manually manipulating the equipment settings to observe performance.
  - 2. Overwriting control system sensor values to simulate a condition, such as overwriting a field sensor reading to be something other than it actually is.
  - 3. Altering setpoints to force equipment into a mode of operation to verify a sequence.
  - 4. Using indirect indicators, such as readings from a control system screen reporting a controllable device status, for testing responses will be allowed only after the actual conditions represented by the indirect indicators have been directly verified, calibrated and documented on the SRC forms (as a pre-functional check/test).



5. Monitoring performance by analyzing the control system Trend data. The CxA will analyze the control system Trend data.
- H. Setup:
1. The Trade Sub-Contractor executing the test shall document the pre-test normal condition on the test form.
  2. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible.
  3. The Trade Sub-Contractor executing the test shall provide all necessary materials, system modifications, overrides, etc. to produce the necessary conditions to execute the test according to the test procedures.
  4. At completion of the test, the Trade Sub-Contractor shall return all affected building equipment and systems to their pre-test normal condition.
- 3.03 COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTING
- A. All Deficiencies and Issues shall be documented on the appropriate forms in use, and will additionally be documented by the CxA on a Cx Issues List.
  - B. Immediate correction of minor Deficiencies identified during testing may be allowed at the discretion of the CxA. In such cases the Deficiency and identified resolution must still be documented on the commissioning form in use.
  - C. When Cx Issues are identified during FPT, the CxA will discuss with the executing Trade Sub-Contractor and/or CxC and determine whether testing can proceed or be suspended. The Commissioning Issue and any identified resolution will be documented on the test form in use in addition to the Commissioning Issues List.
  - D. The CxA will maintain and update the Commissioning Issues List, and document the issues resolution process. Copies will be distributed to the General Contractor, Owner, and Trade Sub-Contractors as appropriate.
  - E. All Deficiencies and Commissioning Issues shall be corrected promptly. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date. The CxA will record completion on the Commissioning Issues List once the issue is successfully back-checked or verified and the CxC shall reschedule testing with the CxA and Trade Sub-Contractor. Testing shall be repeated until passing performance is achieved or the Owner accepts the noted issue.
  - F. When there is a dispute regarding a Cx Issue, whether it is valid or who is responsible, additional parties may be brought into the discussion as appropriate. The CxA will have the final interpretive authority on Cx Issues and Deficiencies and the Owner will have the final approval authority.
  - G. The CxA may recommend solutions to Deficiencies and Commissioning Issues. However, the burden of responsibility to solve, correct and perform required retests is with the General Contractor, Trade Sub-Contractors, and the Design Professional(s).
  - H. Additional Back-check Verifications and Re-testing:
    1. For all Commissioning Issues identified during the pre-functional system readiness activities, the CxA will back-check and verify the completion of the issues where appropriate.
    2. For all Commissioning Issues identified during FPT, retesting is required to verify the resolution of the issue and to complete the FPT.

3. The CxA will witness one re-test for each equipment and will perform one back-check verification of any completed system readiness issue. The Owner may back-charge the General Contractor for any additional fees from the CxA, resulting from any re-testing or repeated system readiness issues list back-checks beyond the first re-test or back-check.
  4. A minimum 48 hour's notice is required for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.
  5. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension.
- I. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

#### 3.04 DEFERRED & SEASONAL TESTING

- A. Before or during the end of the first year Warranty Period, any Seasonal or Deferred Testing as defined in the Cx Plan, shall be completed as part of this contract. Tests shall be conducted by the Trade Sub-Contractor responsible for the equipment and systems, completed in the same manner as all other commissioning tests, and shall be witnessed by the CxA.
- B. The General Contractor shall coordinate with CxA and Owner and schedule all Deferred and Seasonal Testing.
- C. The General Contractor shall make final adjustments to the as-built documentation or drawings for any modifications made during Deferred or Seasonal Testing.

#### 3.05 O&M MANUAL AND TRAINING VERIFICATION

- A. The General Contractor and the CxC shall coordinate and schedule the training for Owner Personnel. The CxC shall ensure that training is completed per the requirements of the construction documents and specifications.
- B. Trade Sub-Contractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned, no less than 14 days prior to start of training. The General Contractor shall submit the training agendas to CxA and Owner for review and approval. The training agendas shall cover the following elements:
  1. Equipment and/or systems included in training
  2. Intended audience
  3. Location of training
  4. Subjects covered (including a brief description and duration, presentation methods, etc.)
  5. Instructor's name and qualifications
  6. Copy of any handout materials or presentations.
- C. The CxA will review the training plans to verify compliance with the specifications.
- D. The General Contractor shall submit to CxA 'attendee signed' attendance sheets for each training session conducted and a copy of the final training presentations.
- E. The CxA will verify with the Owner that the final O&M manuals have been delivered per the Contract Documents.

#### 3.06 COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

- A. Completion of the main commissioning activities (system readiness checks, functional testing, training, and delivery of O&M manuals) shall be accomplished as a prerequisite for substantial completion. Completion of all commissioning issues and any re-testing shall be completed prior to final acceptance of commissioning.

- B. After completion of the commissioning activities and following review of the completed commissioning documents that includes the draft Cx Report executive summary, all test results and the latest Cx Issues List with all remaining commissioning issues and deficiencies, the Owner will provide a formal written acceptance of the project construction phase commissioning. At that point, any remaining construction phase commissioning issues or seasonal/deferred testing will be transferred to the warranty phase and tracked by the CxA as part of the LEED Post-Occupancy Warranty Phase Commissioning.
- C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Final Commissioning Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all General Contractor and Trade Sub-Contractor commissioning documentation.
- D. The Owner's written acceptance of construction phase commissioning will be included in the Final Commissioning Report.
- E. The CxA will complete a LEED Systems Manual for the systems and equipment commissioned, with assistance provided by the CxC and Trade Sub-Contractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:
  - 1. Final version of the BOD and systems narrative.
  - 2. Systems single line diagrams or schematics.
  - 3. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.
  - 4. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, lighting controls, etc.
  - 5. Recommended schedule of major maintenance requirements and frequency, if not already included in the project O&M Manuals.
    - a. A summary of the preventative maintenance and service procedures is recommended in the Systems Manual, for the major MEP equipment, including a schedule matrix checklist (checked as weekly, monthly, quarterly, annually, etc.).
    - b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
    - c. Recommended schedule for calibrating sensors and actuators.

### 3.07 POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

- A. Per the LEED Enhanced Commissioning requirements, no later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility staff, walk the facility and review systems operation to identify any issues. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.
- B. The CxA will also review BAS trend data during the Post-Occupancy Warranty Phase. The BAS Trade Contractor will be responsible for providing post-occupancy trend data to the CxA.
- C. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period. The CxC shall work with the Trade Sub-Contractors and O&M staff to make corrections and modifications as required.

- D. After correcting noted Warranty Phase Cx Issues, the General Contractor shall notify the CxA in writing, and the CxA will back-check and verify that the Warranty Phase Cx Issue was resolved.
- E. Issues identified during the warranty period will remain Warranty Phase Cx Issues until satisfactory completion by General Contractor and back-check verification by CxA, even if the warranty period expires during the correction and back-check period.

END OF SECTION

SECTION 22 21 13 - PLUMBING PIPING, VALVES AND SPECIALTIES

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to the following:
  - 1. Pipe and Fittings
    - a. Sanitary waste and vent
    - b. Storm drain and overflow
    - c. Cold water
    - d. Hot water
    - e. Natural gas
  - 2. Valves
    - a. Water valves
    - b. Natural gas valves
    - c. Balancing valves
    - d. Gas pressure regulator valves
  - 3. Thermometers and gauges
  - 4. Piping specialties
    - a. Pipe escutcheons
    - b. Strainers
    - c. Drip pans
    - d. Air vent
    - e. Dielectric unions
    - f. Unions
    - g. Flanges
    - h. Pipe sleeves
    - i. Sleeve seals
    - j. Valve boxes
    - k. Pipe coating
    - l. Gas connectors

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220500: Basic Materials and Methods
- B. Section 220501: Plumbing
- C. Section 224000: Plumbing Fixtures
- D. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications:
  - 1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
  - 2. Replacement parts shall be readily available and stocked in the USA.
- B. Codes and Standards:
  - 1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
  - 2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
  - 3. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
  - 4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
  - 5. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
  - 6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.
- B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams.
- C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
  - 1. All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Engineer prior to bidding.

OR

- 2. Upon request, the engineer shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.

- B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.
- C. For all Grade B piping specified below grade provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.
- D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturer's names used herein, unless specifically noted that substitutes are not allowed.

## 2.2 STANDARD PIPE AND FITTING

- A. Natural Gas Pipe & Fitting (Above Grade)
  - 1. Pipe: ASTM A53, Schedule 40 black steel.
    - a. Fittings: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel.
    - b. Joints: 2" and smaller, threaded (except in the case of piping located in shafts <<or plenums>> which must be welded); all piping inside the building 2-1/2" and larger, ANSI B16.25 bevelweld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.
  - 2. Flexible Pipe System: Corrugated stainless steel tubing (CSST) equal to Gastite® corrugated stainless steel tubing manufactured from ASTM A240, type 304 stainless steel with a minimum nominal wall thickness of 0.010". System shall comply with ANSI LC-1 "Standard for Fuel Gas Piping Using Corrugated Stainless Steel Tubing (CSST), and carrying listings by CSA International (Certification Number 1009875), ICC Evaluation Services (Report Number ESR-1031) and IAPMO Research & Testing (Certificate of Listing Number 3250). System to be fire rated for installation in plenum applications.
    - a. Fittings and joints: Corrugated stainless steel tube fittings and joints equal to Gastite® mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock™, mechanical capture of the jacket for enhanced tubing protection.
- B. Natural Gas Piping (Below Grade)
  - 1. Polyethylene, Grade 23, Type II, ASTM 2513, plain ends, heat fused joints, orange finish.
  - 2. Fittings:
    - a. Above Grade Carrier Pipe Fittings: ANSI B16.4 malleable iron threaded, ANSI B16.5, flanged; ANSI B16.9, steel bevelweld.
    - b. Above Grade Containment Pipe Fittings: Victaulic grooved fittings.
    - c. Below Grade Carrier Pipe Fittings: UL listed fiberglass fittings as manufactured by Smith.
    - d. Below Grade Containment Fittings: UL listed "Clamshell" fiberglass fittings as manufactured by Smith.
  - 3. Joints:
    - a. Above Grade Carrier Pipe: 2" and smaller, threaded (except piping in shafts or plenums which must be welded); 2 ½" and larger, ANSI B16.25 bevelweld, ANSI B16.5 flanges or ANSI B16.11 socket weld.
    - b. Above Grade Containment Pipe: Victaulic type grooved pipe couplings or equivalent by Gruvlok.

- c. Below Grade Carrier Pipe: Threaded and bonded (T.A.B.) system as manufactured by Smith.
  - d. Below Grade Containment Pipe: UL listed "Clamshell" fiberglass fittings as manufactured by Smith.
- C. Trap Primer Piping:
  - 1. Pipe: Domestic Only, ASTM B88, Type K, soft drawn copper water tube. Fittings: No joints below ground. For pipes below grade double wrap with Scotch Wrap #51 or PASCO Wrap, with 50% overlap.
- D. Domestic Water Pipe & Fittings (Below Grade):
  - 1. Pipe: ASTM B88, Type K hard drawn copper water tube.
  - 2. Fittings: Domestic Only, Elkhart, ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints. Wrap underground piping with Scotch Wrap or Pasco Wrap.
- E. Domestic Cold Water Pipe and Fittings (Above Grade):
  - 1. Pipe: Schedule 10 type 304 stainless steel with roll groove fittings. ASTM A268.
  - 2. Fittings: Victaulic grooved stainless steel fittings.
  - 3. Joints: Roll groove.
- F. Condensate and indirect drains:
  - 1. Pipe: ASTM B88, Type M, hard drawn copper water tube.
  - 2. Fittings: ANSI B16.22, wrought copper.
  - 3. Joints: Lead-free solder joints. Solder shall be lead-free nickel/silver bearing solder meeting ASTM B-32, ASTM B-828. Flux shall be water soluble and shall meet CDA standard test method 1.0 and ASTM B813-91.
  - 4. Insulate condensate drain pipes with minimum ½" insulation to prevent moisture dripping from pipe.
- G. Domestic Hot and Cold Water Pipe & Fittings (Above Grade):
  - 1. Pipe: ASTM B88, Type L, hard drawn copper water tube.
  - 2. Fittings: ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints.  
<<Alternative Domestic Water Pipe Fitting (See Section 3.8F): Copper press fittings shall conform to the material and sizing requirements of ASME B16.22. O-rings for copper press fittings shall be EPDM. Viega/Ridgid or approved equal.>>
  - 3. Pureflow bronze PEX Press Fittings and stainless steel press sleeves.
- H. Domestic Cold and Hot Water Pipe & Fittings Above and Below Grade (2-1/2" and Larger):
  - 1. Pipe: ASTM D1784, Corzan® IPS (iron pipe size) Rigid CPVC (chlorinated polyvinyl chloride) Schedule 80, Cell Class of 24448, NSF certified. Pipe shall meet ASTM F441.
  - 2. Fittings: Fitting shall meet Cell Class 23447 and carry a pressure rating listed by the Plastics Pipe Institute (PPI) of PPI TR-3 and in accordance with ASTM D-2837. ASTM F439 socket, ASTM F437 for threaded CPVC Schedule 80 fittings. Threaded fittings shall have taper pipe threads in accordance with ASTM F1498. Unions and flanges shall meet the requirements of ASTM F1970. Two step-low VOC, ASTM F493 & ASTM F656 primer and solvent cement application per manufacturer's instructions and in accordance with ASTM D-2855 and ASTM F402.
  - 3. Compound manufacturer shall conduct a program that lists those ancillary building products (including, but not limited to: fire stops/caulks, thread sealants, leak detectors/snoop, etc...) that are chemically compatible with the CPVC compounds (pipe and fittings). This compatibility program shall be administered by an independent third party testing agency.
  - 4. Contractor shall have received training from a manufacturer trained representative, and shall have received and be able to show proof of training via the use of "Proof of Training" card or other completion training certificate for the system he is installing.



- I. Domestic Cold and Hot Water Pipe & Fittings Above and Below Grade (2" and Smaller):
  - 1. Pipe: ASTM D1784, FlowGuard Gold® CTS (copper tube size) Rigid CPVC (chlorinated polyvinyl chloride) pipe with a minimum Cell Class of 24448, NSF certified. Pipe shall meet ASTM D2846.
  - 2. Fittings: Fitting shall meet ASTM D1784 with a Cell Class of 23447. One step-low VOC, ASTM F493 solvent cement, application per manufacturer's instructions and in accordance with ASTM D-2855 and ASTM F402.
  - 3. Compound manufacturer shall conduct a program that lists those ancillary building products (including, but not limited to: fire stops/caulks, thread sealants, leak detectors/snoop, etc...) that are chemically compatible with the CPVC compounds (pipe and fittings). This compatibility program shall be administered by an independent third party testing agency.
  - 4. Contractor shall have received training from a manufacturer trained representative, and shall have received and be able to show proof of training via the use of "Proof of Training" card or other completion training certificate for the system he is installing.
- J. Sanitary Sewer, Vent, Rainwater Pipe & Fittings:
  - 1. Pipe: Tyler or AB&I or Charlotte Pipe and Foundry, ASTM A-74, ASTM A-888 cast iron, bituminous coated, "No-Hub". Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and manufactured by AB &I, Charlotte or Tyler. Pipe showing rust or cracks in coating shall be removed and replaced.
  - 2. Fittings: No-hub, ASTM A-888.
  - 3. Couplings Below Grade: Heavy Duty Type 304 stainless steel couplings conforming to FM 1680 with neoprene sealing sleeve conforming to ASTM C-1540 having minimum shield thickness of 28 gauge. Husky SD-4000 or Clamp All 125 only.
  - 4. Couplings Above Grade: Type 304 stainless steel couplings conforming to ASTM C-1540 and neoprene sealing sleeve, having minimum shield thickness of 34 gauge. Anaco or Ideal.
- K. Rainwater Leader Pipe and Fittings (Exposed, Above Grade):
  - 1. Pipe: ASTM B306, DWV class, copper tube.
  - 2. Fittings: ANSI B16.23 cast bronze or ANSI B16.29 wrought copper. Drainage pattern fittings.
  - 3. Joints: Lead free solder. Lead solder shall not be present at the job site.
- L. Vent Piping (Above Grade) (Contractor's Option):
  - 1. Pipe: ASTM B306, DWV class, copper tube.
  - 2. Fittings: Elkhart, ANSI B16.23 cast bronze or ANSI B16.29 wrought copper, sweat solder no lead joint. Submit sample of solder for Engineer's review and approval.
- M. Water Service to Building:
  - 1. Pipe: Class 52 ductile iron, ANSI A21.51, AWWA C1510-70, 150 psi cement lined; factory encased with 8 mil polyethylene tube or sheet.
  - 2. Fittings: ANSI A21.10 mechanical joint, AWWA C110-1971, 250 psi. fittings to be double field wrapped with 2", 20 mil vinyl tape, 50% overlap.
  - 3. All fittings shall be restrained with 2000 psi thrust blocks in accordance with NFPA
  - 4. Fire Protection: Refer to Specification Section 211000.

## 2.3 VALVES: GENERAL

- A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

- B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
- C. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.
- D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
  - 1. Gate, Ball, Check or Butterfly: Apollo, Hammond, Nibco (commercial grade, US manufacturer only), Milwaukee, Victaulic or Watts.
  - 2. Lubricated Plug Valves: Homestead, Resun, or Rockwell.
  - 3. Backflow Preventors: Apollo, Ames, Febco, Cla-Val, Watts or Wilkins.
  - 4. Pressure Reducing Valves: Apollo, Cash-Acme, Cla-Val, Watts, or Wilkins.
  - 5. Solenoid Valves: ASCO, Automatic or Magnatrol.
  - 6. Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, or Tour & Anderson.
- E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.
- F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2 ½" and larger located 8 feet above the floor in mechanical rooms provide chain operator to permit operating the valve from 4'-0" above floor.
- G. Valve Features:
  - 1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
  - 2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
  - 3. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
  - 4. Threaded: Valve ends complying with ANSI B2.1.
  - 5. Solder-Joint: Valve ends complying with ANSI B16.18.
  - 6. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

## 2.4 DOMESTIC PLUMBING SERVICE VALVES

- A. Gate Valves:
  - 1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 cast bronze body, soldered ends, bronze bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum hand-wheel.
  - 2. 2-1/2" and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel.

B. Butterfly Valves:

1. 3" and Larger: MSS SP-67, lug wafer, ductile iron body, stainless steel disc, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Mount stem in horizontal position. Hammond 6100 series.

C. Ball Valves:

1. 2 1/2" and Smaller: 600 psi, 2 piece, bronze body, soldered ends for copper pipe and threaded ends for iron pipe, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port. Apollo 70-200 series.

D. Check Valves:

1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc.
2. 2-1/2" and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings.
3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, stainless steel guide and spring. Watt #6015.

2.5 NATURAL GAS AND LP GAS

A. Ball Valves:

1. 1/2" and 3/4": Brass body, U.L. listed, CSA approved for pressure of system, bronze ball valve, 175 WOG, with integral lever handle. Apollo 64 series or Watts #FBV-1.
2. 1" thru 1-1/2": 175 psi working pressure, CSA and UL approved, bronze body, welded ends, stainless steel ball, stainless steel stem, steel handle with memory stop tab, conventional port.
3. Lubricated Plug Valve, 2" and Larger: Class 125, MSS SP-78, 200 PSI, UL listed, CSA approved for pressure of system, lubricated plug type, semi-steel body, loose wrench operated, straight way pattern round port, combination button head fitting and lubricant screw, Teflon seal and discs.

B. Seismic Gas Shutoff Valves:

1. 3/4" thru 2" (low and medium pressure, screwed body): U.L. Listed valve meeting ASCE 25-97, positive closure, soft seal seating, visual open-close indicator, manual reset, and closure time interval within 5 seconds when subjected to a sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Koso/California Valve Series EV, or approved equal, sized for 0.5 PSI or 20 PSI max operating pressure, respectively.
2. 2", 3" and 4" (High pressure, screwed body): U.L. Listed valve meeting ASCE 25-97, manual reset, soft seat construction for positive sealing, visual open-close indicator, tripping mechanism with non-creeping rolling latch, and closure time interval within 5 seconds when subjected to sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Koso/California Valve Series EV315, or approved equal, sized for 20 PSI max. operating pressure.
3. 6" (high Pressure, Flanged body): U.L. Listed valve meeting ASCE 25-97, manual reset, soft seat construction for positive sealing, visual open-close indicator, tripping mechanism with non-creeping rolling latch, and closure time interval within 5 seconds when subjected to sinusoidal oscillation with peak acceleration of 0.3G and a period of 0.4 seconds. Koso/California Valve Series EV317, or approved equal, sized for 60 PSI max. operating pressure.

## 2.6 GAS PRESSURE REGULATOR VALVES

- A. Diaphragm operated, steel construction of size and capacity as indicated on drawings. Regulators shall be approved serving gas supplier, CSA and UL listed. Fisher, Sherwood, or approved equal.

## 2.7 FIRE PROTECTION VALVES:

- A. Refer to Section 211000.

## 2.8 THERMOMETERS AND GAUGES

- A. General:
  - 1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
  - 2. No mercury shall be used in thermometers due to hazardous material classification.
  - 3. Acceptable Manufacturers: Weksler, Winters, Terice, Marshalltown or US Gauge.

## 2.9 PIPING SPECIALTIES

- A. General:
  - 1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.
- B. Pipe Escutcheons:
  - 1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
  - 2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
  - 3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.
- C. Low Pressure Y-Type Pipeline Strainers:
  - 1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations at 233 0.045" perforations per square inch.
  - 2. Threaded ends, 2" and smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Sarco, Wheatley or Mueller.
  - 3. Flanged ends, 2-1/2" and larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with hose bibb. Sarco, Wheatley or Mueller.
  - 4. <<Grooved ends 2 1/2" and larger: Ductile iron body, bolted screen retainer with off center blowdown fitted with hose bibb. Victaulic or Gustin-Bacon.>>

- D. Drip Pans:
1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection. Extend 1" drain to nearest approved receptor.
- E. Air Vent with Valves:
1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A 3/8" type "L" copper tubing drain line shall be run to drain receptor to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Hoffman #79 or Dole.
- F. Dielectric Unions:
1. Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
- G. Dielectric Flanges: Provide dielectric flanges for flanged transitions between dissimilar metal piping. Watts Series 3100 or approved equal.
- H. Unions:
1. Unions shall be of type specified in following schedule:
    - a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
    - b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
    - c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
    - d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
    - e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
    - f. Manufacturer: EPCO, Mueller, Stanley G. Flagg or Watts.
- I. Flanges:
1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
  2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
  3. Type of pipe and corresponding flanges as follows:
    - a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
    - b. Welded Steel Pipe, 150 lb. black forges steel welding flanges, 1/16" raised fact ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.
- J. Pipe Sleeves:
1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.

2. Sleeves shall provide a minimum ½" annular clearance around pipe.
3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6", 14 gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AML or Shamrock. Floor sleeves to extend a minimum of 1" above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

K. Sleeve Seals:

1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

- L. Valve Boxes: Concrete body, cast iron cover with vandal resistant screws, extensions as required to extend full depth to valve. Valve box cover lettering shall correspond to the valve service, "Water", "Gas", "Fire", "Sewer", etc. Christy #G8 or equal.

2.10 PIPE COATING

- A. All underground steel and copper pipe fittings, and all above ground steel and copper pipe and fittings in corrosive air environments shall be covered with one of the following methods:
1. Twice Wrap 20 Mil. Scotch Wrap PVC No. 51, 50% overlap.
  2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mil. Scotch Wrap No. 51 or Pasco Wrap 20 mil weight.
- B. Furnish corrugated stainless steel tubing (CSST) with factory-applied corrosion –resistant polyethylene jacket for use in corrosive atmosphere. Coating properties include the following:
1. Gastite corrugated stainless steel tube jacket shall be UV-Resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density.

2.11 GAS CONNECTORS

- A. General Areas: CSA rated, UL listed, braided stainless steel gas hose of size and capacity to meet appliance input requirements.
- B. Food Service Equipment: CSA rated, UL listed, plastic coated braided stainless steel gas hose with quick disconnect, swivel fitting and coiled restraining device. Dormont #1675BPQS or approved equal.
- C. Gas connectors for outdoor applications shall be listed for exterior use.

2.12 EXPANSION COMPENSATORS

- A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.
- B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.
- C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop or approved equal.
- D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal.
- E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS or approved equal.
  - 1. For non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26" vacuum at 250°F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or approved equal.
  - 2. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes ¼" to 4". Provide two composition gaskets for each joint. Barco or approved equal.
- F. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.
- G. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
- B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

#### 3.2 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

#### 3.3 INSTALLATION

- A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.
- B. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:
  - 1. All formed concrete work.
  - 2. Framed openings in masonry and other Architectural and Structural elements.
  - 3. Wood grounds and nailing strips in masonry and concrete.
  - 4. Sloping of floors to drains and floor sinks.
  - 5. Sloping of roof-to-roof drains and overflow drains.
- C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

#### 3.4 WORKING PRESSURES

- A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.
- B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.
- C. Low pressure, 0.5 psig (14 inch Water Column) or less, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.
- D. Medium pressure, over 0.5 psig (14 inch Water Column) up to 5 psig, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.



### 3.5 PIPES SIZES TO EQUIPMENT

- A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.
- B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

### 3.6 PIPING INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.
- C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces. Route drip pan drain piping to floor drain, floor sink or other approved receptor.
- D. CSST tubing, fitting, and strike-protection are to be Gastite® and shall be installed per the current version of the Gastite® Design & Installation Guide and per **[Local Code]**. Gastite® supplied training shall be obtained by all installers prior to installation. The gas-piping system shall be pressure tested in accordance with all requirements of **[Local Code]**, ANSI LC-1 and the most current edition of the Gastite® Design and Installation Guide.

### 3.7 WELDING

- A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping".
  - 1. Submit for approval the names, identification, and welder's assigned number, letter or symbol of welders assigned to this project.
  - 2. The assigned identification symbol shall be used to identify the work of each welder and shall be indelibly stamped immediately upon completion of each weld.

3. Welders shall be tested and certified for all positions.
4. Submit identifying stenciled test coupons made by each operator.
5. Any or all welders may be required to retake welding certification tests without additional expense.
6. When so requested, a welder shall not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
7. Recertification of the welder shall be made after the welder has taken and passed the required tests.
8. Where piping 1-1/2 inches and smaller is butt or socket welded, submit 3 samples of test welds for approval.

### 3.8 PIPING SYSTEM JOINTS

- A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.
- B. Provide joints of type indicated in each piping system.
- C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.
  1. Manufacturers:
    - a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
    - b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".
- E. Braze copper tube and fitting socket or extrude joints (T-drill) with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. Medical gas system brazing shall be as specified in Section 226313. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.
- F. Corrugated stainless steel tube (CSST) fittings joints: Gastite<sup>®</sup> mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock<sup>™</sup>, mechanical capture of the jacket for enhanced tubing protection.

### 3.9 VALVES

- A. General: Except as otherwise indicated, comply with the following requirements:
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided as necessary.  
<<Install valves on all services connected to kitchen equipment. >>
  2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
  3. Install butterfly valves with stems mounted horizontally.
  4. All valves mounted higher than 7' above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6' above floor.
  5. <<Provide Seismic shut off valve on gas main downstream of meter.>>
- B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.
- C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
1. Copper Pipe, 2-1/2" and Smaller: Soldered-joint valves.
  2. Steel Pipe, 2" and Smaller: Threaded joint valves.
  3. Larger Pipe Sizes: One of the following, at installer's option:
    - a. Flanged valves.
    - b. Lug valves.
- D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
- E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.
- F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, globe, and butterfly valves to comply with ASME B31.9.
- G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
- H. Wafer Check: Install between 2 flanges in horizontal or vertical position.
- I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception.
- J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.
- K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.
- L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

### 3.10 TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.
- B. Install in the following locations, and elsewhere as indicated:
  - 1. At outlet of hot water heaters.
  - 2. At inlet and outlet of boilers.

### 3.11 MECHANICAL SLEEVE SEALS

- A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.
- B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer's installation instructions.

### 3.12 SUPPORTS AND HANGERS (See 22050)

### 3.13 EXPANSION LOOPS

- A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.
- B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

### 3.14 PIPE INSPECTIONS

- A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. "Rough-in" "top-out" and final.
- B. Inspection – Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.
- C. Inspection – Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceilings. Notify the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

### 3.15 CLEANING, FLUSHING, DISINFECTING

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).
- B. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.
- C. Inspect pressure piping in accordance with procedures of ASME B31.
- D. Disinfect water mains and water service piping in accordance with Section 220501.

### 3.16 TESTING

- A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.
- B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.
- C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

System	Test Medium	Test Pressure	Tolerance-Test Period
Domestic Water	Water	150 psig	None – 8 hours
Soil and Waste	Water	10 ft head, 5 psi	No leaks – 8 hours
Vent	Water	Top of Vent Terminal	No leaks – 8 hours
Storm	Water	Top of Roof Drain	No leaks – 8 hours
Automatic Fire	Water	200 psig	None – 8 hours
Natural Gas/Propane	Air or Nitrogen	100 psig	None – 24 hours

- D. Final Drainage, Waste and Vent Test: Upon project closeout, Contractor shall perform and certify that the DWV system has passed the following test:

1. After all plumbing fixtures have been installed and their traps filled with water, all vent terminals and building drains shall be closed and a U-tube water manometer shall be inserted into the trap of water closet and an air compressor testing apparatus shall be attached to any suitable opening. An air pressure of 1" water column as indicated on the manometer shall be introduced into the system. The pressure shall hold constant for a period of 15 minutes without the introduction of additional air. Leaks revealed during this test may be located by smoke test or other recognition methods.
- E. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.
- F. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, air vents, trap primers, and vacuum breakers for proper performance. Test all air vent points to ensure that all air has been vented.
- G. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.

END OF SECTION

## SECTION 22 40 00 - PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the installation of plumbing fixtures and trim.

#### 1.3 RELATED WORK IN OTHER SECTIONS

- A. Section 220500: Basic Materials and Methods
- B. Section 220501: Plumbing
- C. Section 01 81 13: Sustainable Design Requirements

#### 1.4 SUBMITTALS

- A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
  - 1. Plumbing fixtures.
  - 2. Piping specialties.
  - 3. Toilets.
  - 4. Urinals.
  - 5. Lavatories.
  - 6. Sinks.
  - 7. Drinking fountains.
- B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with Architectural Woodwork shop drawings specified in Division 06 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.
- C. Samples: Submit samples of any piece of equipment requested by Architect for review and approval.
- D. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

- E. LEED certification data as specified in Division 1, Section 01 81 13, "Sustainable Design Requirements", for the following LEED credits:
  - 1. Prerequisite WE 1, Water Use Reduction
  - 2. Credit WE 3, Water Use Reduction

#### 1.5 CODES AND STANDARDS

- A.
- B. All fixtures and faucets must meet all requirements of Americans with Disabilities Act (ADA).
- C. State Energy Code
- D. ARI Standard 1010: "Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged products from project site.

#### 1.7 MAINTENANCE

- A. Extra Stock:
  - 1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures, flush valves, and trim to Owner with receipt in a quantity of one device for each 10 fixtures.
  - 2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, o-rings, sleeves, and seats in a quantity of 1 kit for each 10 faucets.

### PART 2 - PRODUCTS (see plumbing schedule)

#### 2.1 GENERAL

- A. Provide fixtures as specified. Fixtures in any secure or public areas shall be vandal proofed.
- B. Architect/Engineer shall review and approve any substitution requested by Contractor prior to bid submittal.
- C. Provide fixture as specified, acceptable manufacturers:
  - 1. Vitreous China or Cast Iron Fixtures: American Standard, Eljer, Zurn, Toto or Kohler.
  - 2. Stainless Steel Sinks: Elkay or Just
    - a. All stainless steel is 18 gauge, type 304 unless otherwise specified.
  - 3. Drinking Fountains: Elkay or Haws.
  - 4. Terrazzo Service Sinks: Florestone or Stern Williams.
- D. Provide faucet as specified. Acceptable manufacturers: Chicago Faucets, Zurn, Symmons, T and S or as indicated.



- E. Provide flush valve as specified. Acceptable manufacturers: Sloan, Hydrotek or Zurn.
- F. Provide commercial grade toilet seat as specified. Acceptable manufacturers: Beneke, Bemis, Church or Olsonite.
- G. Provide heavy-duty cast iron commercial grade carrier as specified. Provide compact carriers where space is limited. Acceptable manufacturers: Ancon, Jay R. Smith, Wade or Zurn. No plastic parts on foundry items.
  - 1. Wall hung water closet: J.R. Smith figs: 0210L/R Y-M12 <<- M40>>, 0210DY-M12, 0240L/R Y-M12, 0240DY-M12, 0410R/L Y-M12 and 0410DY-M12.
  - 2. Wall hung urinal: J.R. Smith fig: 0634-M12 or Zurn Z-1221-58.
  - 3. Wall hung lavatory: J.R. Smith fig: 0700(D) –M31 concealed arm carrier.
- H. Provide heavy duty commercial grade 17-gauge P-Trap and supplies with stops as specified. Provide heavy duty commercial grade lavatory supplies. Provide supplies meeting AB1953 no lead requirements. Supplies shall be ½"x 3/8" x 12" ground joint flexible riser with loose key angle stop with chrome plates I.P.S. brass nipple. Sink supplies shall be ½" x 12" ground joint flexible riser with loose-key angle stop with chrome plated I.P.S. brass nipple. Provide bell type escutcheons for both P-trap and supplies. Acceptable manufacturers: Zurn, Brasscraft, Chicago, or McGuire.
  - 1. P-trap - Lav: McGuire C8902-DF or Zurn Z-8701.
  - 2. P-trap - Sink: McGuire C8912-DF or Zurn Z-8702.
  - 3. Supply for Lavatory: McGuire LFH2165LK or Zurn ZH88-XL-LK.
  - 4. Offset supply for barrier free lavatory: McGuire 158 WC.
  - 5. Supply for Sink: McGuire LFH2167LK or Zurn ZH8803-XL-LR.
  - 6. Supply for Water Closet: McGuire H2169LK or Zurn ZH-8807-CR.
  - 7. Escutcheons: McGuire WE00D Series, wrought brass, bell type.
  - 8. Lavatory grid strainer: McGuire 155A or Zurn Z-8743.
  - 9. Barrier-free lavatory offset grid strainer: McGuire 155WC or Zurn 8746.
  - 10. Sink Strainer: Elkay LK-18B.
- I. Insulation: provide white molded closed cell vinyl pre-fab insulation on P-Trap and on both hot and cold water supply for barrier free lavatories and sinks. Acceptable manufacturers: Plumberex, True-Bro, and Zurn. Bag type insulators are not acceptable.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.
- C. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.
- D. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.
- E. Comply with the installation requirements of ADA with respect to plumbing fixtures for the physically handicapped.

- F. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.
- G. Install a stop valve in an accessible location in the water connection to each fixture.
- H. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Seal fixtures to walls and floors using silicone sealant as specified in Division 07. Match sealant color to fixture color.
- J. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
- K. Inspect each installed unit for damage. Replace damaged fixtures.
- L. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream.
- M. Replace washers or cartridges of leaking or dripping faucets and stops.
- N. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.
- O. During construction cover all installed fixtures, sinks, and water coolers with cardboard boxes and wrap with Visqueen.
- P. Provide flush valve and faucet support behind wall.

END OF SECTION

# **DIVISION 23**

## **HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)**

## SECTION 23 05 00 - BASIC HVAC MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

#### 1.2 SCOPE OF THIS SECTION

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
  - 1. Compliance with all codes and standards applicable to this jurisdiction
  - 2. Shop Drawings for Equipment
  - 3. Coordination Documents
  - 4. Record Drawings
  - 5. Start-up Service and Building Commissioning
  - 6. Instruction, Maintenance, and O & M Manuals
  - 7. Meeting Project Safety and Indemnity requirements
  - 8. Proper Cleaning and Closing
  - 9. Supplying proper Warranty information
  - 10. Supply specified Guarantee documentation
  - 11. Design and provision of Supports and Anchors
  - 12. Pipe Portals
  - 13. Equipment Rails
  - 14. Access Panels and Doors
  - 15. Identification Markers
  - 16. Coordination of Electrical requirements for equipment provided

#### 1.3 DESCRIPTION OF WORK

- A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.
- B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.
- C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.
- D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

#### 1.4 DESCRIPTION OF BID DOCUMENTS

##### A. Specifications:

1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.

##### B. Drawings:

1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
2. Before proceeding with work check and verify all dimensions.
3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

#### 1.5 DEFINITIONS

- A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
- B. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.
- C. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
- D. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
- E. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
- F. "Connect": Complete hook-up of item with required service.
- G. "Exposed": Not installed underground or "concealed."
- H. "Furnish": To supply equipment and products as specified.
- I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
- J. "Install": To erect, mount and connect complete with related accessories.
- K. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
- L. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- M. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.
- N. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
- O. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
- P. "Shall": An exhortation or command to complete the specified task.
- Q. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
- R. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

- S. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
- T. “Will”: A desire to complete the specified task. Allows some flexibility in application as opposed to “Shall”.
- U. “Wiring”: Raceway, fittings, wire, boxes and related items.
- V. “Work”: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

- A. All Division 23 Mechanical sections included herein.
- B. Division 33: Utility Site Work.
  - 1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.
- C. Division 03: Concrete.
  - 1. All concrete work for Mechanical Division shall be included in Division 23 under the appropriate Sections and shall include:
    - a. Concrete curbs and housekeeping pads for the mechanical equipment.
    - b. Thrust blocks, pads, and boxes for mechanical equipment.
    - c. Coordination of floor drain and floor sink installations in sloped floors.
- D. Division 07: Thermal and Moisture Protection.
  - 1. Flashing and sheet metal
  - 2. Sealants and caulking
  - 3. Firestopping
- E. Division 09: Painting:
  - 1. Division 23 installers shall perform all painting, except where specifically stated otherwise in Division 09.
  - 2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials.
  - 3. Paint all exposed gas piping, interior and exterior to the building, yellow.
- F. Division 10: Miscellaneous Metals.
  - 1. Exterior louvers and grilles shall be included in this Section.
- G. Division 26: Electrical is related to work of:
  - 1. Power connections to all mechanical equipment
- H. Division 28: Electronic Safety and Security is related to work of:
  - 1. Fire protection alarms and relays
  - 2. Smoke detector and monitoring
  - 3. Life Safety Systems
- I. Division 01, Section 01 81 13, “Sustainable Design Requirements”
- J. Division 01, Section 01 73 20, “Indoor Air Quality”

1.7 CODES AND STANDARDS

- A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.
- B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.
- C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.
- D. All mechanical work shall comply with the Americans with Disabilities Act (ADA).
- E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
- F. Provide in accordance with rules and regulations of the following:
  - 1. Building Codes enforced by the Authority Having Jurisdiction in California:
    - a. 2010 Building Standards Administrative Code, Part 1, Title 24 C.C.R.
    - b. 2010 California Building Code (CBC), Part 2, Title 24 C.C.R.
    - c. (2009 International Building Code and 2010 California Amendments)
    - d. 2010 California Electrical Code (CEC), Part 3, Title 24 C.C.R.
    - e. (2008 National Electrical Code and 2010 California Amendments)
    - f. 2010 California Mechanical Code (CMC) Part 4, Title 24 C.C.R.
    - g. 2009 Uniform Mechanical Code and 2010 California Amendments)
    - h. 2010 California Plumbing Code (CPC), Part 5, Title 24 C.C.R.
    - i. (2009 Uniform Plumbing Code and 2010 California Amendments)
    - j. 2010 California Energy Code (CEC), Part 6, Title 24 C.C.R.
    - k. 2010 California Fire Code, Part 9, Title 24 C.C.R.
    - l. (2009 International Fire Code and 2010 California Amendments)
    - m. 2010 California Green building Standards Code (CALGreen), Part 11, Title 24 C.C.R.
    - n. 2010 California Referenced Standards, Part 12, Title 24 C.C.R.
    - o. Title 19 C.C.R. Public Safety, State Fire Marshal Regulations.
  - 2. Local, city, county and state codes and ordinances
  - 3. Local Bureau of Buildings
  - 4. Local Health Department
  - 5. Local and State Fire Prevention Districts
  - 6. State Administrative Codes
- G. Provide in accordance with appropriate referenced standards of the following:
  - 1. NFPA - National Fire Protection Association
  - 2. AABC - Associated Air Balance Council
  - 3. CSA - Canadian Standards Association
  - 4. ADC - Air Diffuser Council
  - 5. AMCA - Air Moving and Conditioning Association
  - 6. ANSI - American National Standards Institute
  - 7. ARI - Air Conditioning and Refrigeration Institute
  - 8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
  - 9. ASME - American Society of Mechanical Engineers
  - 10. ASTM - American Society for Testing Materials
  - 11. AWS - American Welding Society
  - 12. FM - Factory Mutual
  - 13. MSS - Manufacturer's Standardization Society
  - 14. NEMA - National Electrical Manufacturer's Association

- 15. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
- 16. UL - Underwriter's Laboratories
- 17. ADA - Americans with Disabilities Act
- 18. ETL - Electrical Testing Laboratories

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.
- B. Current Models. All work shall be as follows:
  - 1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
  - 2. Replacement parts shall be readily available and stocked in the USA.
- C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

#### 1.9 GENERAL REQUIREMENTS

- A. Examine all existing conditions at building site.
- B. Review contract documents and technical specifications for extent of new work to be provided.
- C. Provide and pay for all permits, licenses, fees and inspections.
- D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 233113 Air Distribution for a summary of requirements.
- E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.
- F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.
- G. Coordinate mechanical equipment and materials installation with other building components.
- H. Verify all dimensions by field measurements.
- I. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- J. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- K. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- L. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
- M. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- N. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.



- O. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
- P. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- Q. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.
- R. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- S. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.
- T. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

#### 1.10 MINOR DEVIATIONS

- A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.
- B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include:
  - 1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications.
  - 2. Minor deviations from the mechanical plans required by architectural and structural coordination.
- C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work". Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.
- D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.
- E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

#### 1.11 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
  - 1. The proposed substitution does not affect dimensions shown on drawings.
  - 2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.

3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
  4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.
- 1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS
- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
  - B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.
  - C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.
  - D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.
- 1.13 UNIT PRICING SUBMITTALS
- A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
  - B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer's names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
    1. Indicate substituted items.
    2. Identify test and balancing agency.
    3. Identify independent testing laboratory for water analysis.
  - C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.
  - D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.
- 1.14 COORDINATION DOCUMENTS
- A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable

maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

- B. The Drawings shall be prepared as follows:
  - 1. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of  $1/4" = 1'-0"$  or larger, on reproducible media sheets (vellum) or AutoCAD disks. Obtain reproducible or AutoCAD and/or Revit files of the HVAC design from the Architect, or Engineer, at cost plus. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping. Plans shall also indicate proposed ceiling grid and lighting layout, as shown on electrical plans and reflected ceiling plans.
  - 2. The Plumbing Contractor shall obtain reproducible plans or AutoCAD disks from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
  - 3. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD disks with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
  - 4. Plans are to incorporate all addenda items and change orders.
  - 5. Distribute plans to all trades and provide additional coordination as needed.
- C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.
- D. Provide means of access to all valves, dampers, controllers, operable devices, and other apparatus that may require adjustment or servicing.
- E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.
- F. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.
- G. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

#### 1.15 RECORD DRAWINGS

- A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record". Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
  - 1. Obtain a clean set of reproducible from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducible in a neat and orderly fashion.  
OR
  - 2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

- B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.
- C. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
- E. Refer also to Special Conditions in Division 01 for full scope of requirements.

#### 1.16 START-UP SERVICE AND BUILDING COMMISSIONING

- A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.
- B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.
- C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.
- D. Refer to other Division 23 Sections for additional requirements.

#### 1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

- A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.
- B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23 to be no less than two hours for each piece of equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

#### 1.18 POSTED OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.19 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.
- B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
- C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.20 CLEANING AND CLOSING

- A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
- B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.21 WARRANTIES

- A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
- B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
- C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.22 GUARANTEE

- A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
- B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

- B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

## 2.2 SUPPORTS AND ANCHORS

- A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
  2. ASCE 7-05: “American Society of Civil Engineers.”
  3. 2009 International Building Code (IBC)
  4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
  5. SMACNA: “Seismic Restraint Manual: Guidelines for Mechanical Systems.”
  6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
  7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
  8. Manufacturer: B-Line, Grinnell, Michigan, Tolco, Kin-Line, Simpson, or Superstrut.
- B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
1. Adjustable Steel Clevis Hangers: MSS Type 1.
  2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
  3. U-Bolts: MSS Type 24.
  4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
    - a. Plate: Unguided type.
    - b. Plate: Guided type.
    - c. Plate: Hold-down clamp type.
  5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
  6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
  7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
  8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
  9. Adjustable Roller Hangers: MSS Type 43.
  10. Pipe Roll Stands: MSS Type 44.
  11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
- C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.
- D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.
- E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
1. Steel Turnbuckles: MSS Type 13.
  2. Steel Clevises: MSS Type 14.
  3. Swivel Turnbuckles: MSS Type 15.

4. Malleable Iron Eye Sockets: MSS Type 16.
  5. Steel Weldless Eye Nuts: MSS Type 17.
- F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
  2. Steel Brackets: One of the following for indicated loading:
    - a. Light Duty: MSS Type 31.
    - b. Medium Duty: MSS Type 32.
    - c. Heavy Duty: MSS Type 33.
  3. Horizontal Travelers: MSS Type 58.
  4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
  5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.
- G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
  2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
  3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
  4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.
- H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
  2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
  3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
  4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
  5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

## 2.3 PIPE PORTALS

- A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.
- B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
  2. Insulation to be 1-1/2" thick, 3 lb density rigid fiberglass.
  3. Curb to have a raised 3" (minimum), 45° cant.

4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
5. Curb height to be 8" (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
8. Manufacturer: Roof Products Systems or Pate.

## 2.4 EQUIPMENT/PIPING RAILS

- A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.
- B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
  1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
  2. Provide internal reinforcing supports welded as required to meet application requirements.
  3. Equipment rails to have raised 3" (minimum), 45° cant.
  4. Equipment rails to have 1-1/2" x 1-1/2" wood nailer (minimum) and counterflashing.
  5. Equipment rail height to be 6" (minimum) above roof deck.
  6. Cant shall be raised to match roof insulation thickness.
- C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.
- D. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

## 2.5 ACCESS PANELS AND ACCESS DOORS

- A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.
- B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
- C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.
- D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

## 2.6 IDENTIFICATION MARKERS

- A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type



is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:

1. Snap-On Type: Provide pre-printed, semi-rigid snap-on, color coded pipe markers, complying with ANSI A13.1.
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Plastic Duct Markers:

1. Provide 4 1/2" x 6" laminated plastic, ANSI A13.1 color coded duct markers with white core lettering.
2. Nomenclature: Include the following:
  - a. Direction of air flow
3. Duct service (supply, return, exhaust, etc.).
  - a. Duct origin (from)
  - b. Duct destination (to)
  - c. Design cfm
4. Provide a minimum of every 20 feet on all ducts with a diameter or width greater than 12".

D. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

E. Valve Tags:

1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
2. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
4. Access Panel Markers: Provide 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.
5. Non-potable Water Tags: 1/16" thick, engraved, plastic tags as indicated on Drawings.

F. Plastic Equipment Signs:

1. Provide 4-1/2" x 6" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.

2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
  - a. Name and plan number.
  - b. Equipment service.
  - c. Design capacity.
  - d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

G. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

## 2.7 ELECTRICAL

### A. General:

1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

### B. Quality Assurance:

1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

### C. Motors:

1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.
4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
  - a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
  - b. VFD driven motors to be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device or as an insulated

- bearing motor.
  - c. Bearings:
    - 1) Ball or roller bearings with inner and outer shaft seals.
    - 2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
    - 3) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
    - 4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
    - 5) Enclosure Type:
      - a) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      - b) Guarded drip-proof motors where exposed to contact by employees or building occupants.
      - c) Weather protected Type I for outdoor use, Type II where not housed.
  - d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
  - e. Noise Rating: "Quiet."
  - f. Efficiency:
    - 1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
    - 2) Motors shall meet the NEMA premium efficiency standard
  - g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
- D. Starters and Electrical Devices:
- 1. Motor Starter Characteristics:
    - a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
    - b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
  - 2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
  - 3. Magnetic Starters:
    - a. Heavy duty, oil resistant, hand-off-auto (HOA) or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
    - b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
    - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
    - d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
    - e. Externally operated manual reset.
    - f. Under-voltage release or protection for all motors over 20 hp.
  - 4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:

1. General: 14 gauge, Type THHN, color coded, installed in conduit.
2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:

1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL

- A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
- B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

- A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
  1. If the contractor must deviate from the manufacturer's recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

- A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating ceiling air outlets, wall registers, etc.
- B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

- A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

- B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.
- C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.
- D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- G. Support sprinkler piping and gas independently of other piping.
- H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- I. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

1. Steel Pipe (Water Filled):		
<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 1 1/4"	5 feet	3/8"
1 1/2" to 2"	7 feet	3/8"
2 1/2" to 3"	10 feet	1/2"
4" and larger	12 feet	5/8"
2. Steel Pipe (Gas/Air Filled):		
<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 1 1/4"	6 feet	3/8"
1 1/2" and larger	10 feet	1/2"
3. Copper Pipe:		
<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	6 feet	3/8"
2 1/2" and larger	8 feet	1/2"
4. Glass Pipe:		
<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	6 feet	3/8"
2 1/2" and larger	8 feet	1/2"
5. Plastic/Fiberglass Pipe:		
<u>Pipe Size</u>	<u>Max. Hanger Spacing</u>	<u>Rod Size</u>
1/2" to 2"	4 feet	3/8"
2 1/2" and larger	6 feet	1/2"

6. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.

J. Sloping, Air Venting, and Draining:

1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

<u>Service</u>	<u>Inclination</u>	<u>Slope</u>
Heating Water	Up	1" per 40'
Steam	Down	1" per 40'
Chilled Water	Up	1" per 40'
Condensing Water	Up	1" per 40'

2. Provide eccentric reducers in horizontal piping for all sizing changes:
  - a. Heating and chilled water piping-top side flat.
  - b. Steam piping-bottom side flat.
3. Connect all heating and chilled water branch piping to the bottom of their respective mains.
4. Connect steam supply branch piping to the top of mains.
5. Provide drain valves and hose adapters at all low points in piping.
6. Provide vents at all high points in water piping.

K. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
  - a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
  - b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
  - c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:

1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Equipment Supports:

1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:

1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

- A. Install per manufacturer's instructions.
- B. Coordinate with other trades so units are installed when roofing is being installed.
- C. Verify roof insulation thickness and adjust raise of cant to match.

3.6 ELECTRICAL REQUIREMENTS

- A. Mechanical Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.
- B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.
- C. Division 23 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:
  1. Division 23 Mechanical Responsibilities:
    - a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
    - b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
    - c. VARIABLE FREQUENCY DRIVES: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
    - d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.

- e. CONTROLS: Division 23 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
    - 1) Control relays necessary for controlling Division 23 equipment.
    - 2) Control transformers necessary for providing power to controls for Division 23 equipment.
    - 3) Line voltage thermostats.
    - 4) Low or non-load voltage control components.
    - 5) Remote bulb thermostats.
    - 6) Non-life safety related valve or damper actuators.
    - 7) Float switches.
    - 8) Solenoid valves, EP and PE switches.
    - 9) Refrigeration controls. (Division 26 provides power to refrigeration panels.)
  - f. FIRE AND LIFE SAFETY EQUIPMENT:
    - 1) Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
      - a) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for proof of closure. (See Section 233113.)
      - b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
    - 2) Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.
    - 3) Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.
- D. Division 26 has responsibilities for electrically powered or controlled mechanical equipment, which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:
- 1. Division 26 Electrical Responsibilities:
    - a. MOTORS: Provide the power wiring for the motors.
    - b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
    - c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD's, which are not specified to be installed on Division 23 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.



- d. DISCONNECTS: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
- e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
- f. FIRE AND LIFE SAFETY EQUIPMENT:
  - 1) Fire/Smoke Dampers: Division 26 is responsible for power wiring to the damper and as follows:
    - a) Where these dampers are part of an integrated smoke control system Division 26 is responsible for providing the detectors and for all fire detection system wiring necessary to integrate dampers and related end switches into the system.
    - b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
  - 2) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
  - 3) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.
- 2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- 3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- 4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
- 5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- 6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

### 3.7 PAINTING

- A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.
- B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
  - 1. Exposed copper piping.
  - 2. Aluminum jacketed outdoor insulated piping.

### 3.8 IDENTIFICATION MARKERS

- A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Piping System Identification:
  - 1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
  - 2. Locate pipe markers as follows:
    - a. Near each valve and control device.
    - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
    - c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
    - d. At access doors, manholes, and similar access points which permit view of concealed piping.
    - e. Near major equipment items and other points of origination and termination.
    - f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.
- C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.
- D. Ductwork Identification: A minimum of every 20' for all ductwork 12" or more in diameter or width.
- E. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
  - 1. Main control and operating valves, including safety devices.
  - 2. Meters, gauges, thermometers, and similar units.
  - 3. Pumps, compressors, chillers, and similar motor-driven units.
  - 4. Hot water system mixing valves and similar equipment.
  - 5. Boilers, heat exchangers and similar equipment.
  - 6. Fans, blowers, primary balancing dampers, and mixing boxes.
  - 7. Packaged HVAC central-station and zone-type units.
  - 8. Tanks and pressure vessels.
  - 9. Strainers, filters, treatment systems and similar equipment.
  - 10. Sprinkler and standpipe equipment.

- F. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

### 3.9 VIBRATION AND DYNAMIC BALANCING

- A. Vibration tolerances shall be as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
  - 1. All Fans: Below severity chart labeled "FAIR", maximum velocity of 0.0785 in/sec, peak.
  - 2. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
  - 3. Compressors: Same as pumps.
- B. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

### 3.10 TESTING

- A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.
- B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.
- C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.
- D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.
- E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION

SECTION 23 05 29 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The requirements of Section 23 05 13 apply to all Work of Division 23.
- B. Work in this Section includes, but is not necessarily limited to, furnishing all labor, materials, and equipment for the installation of vibration isolation mounts, brackets, base frames where required, seismic restraints, flexible connectors, pipe isolation hangers, and ductwork isolation hangers. The installation shall be complete in every respect, tested, and adjusted to be in excellent working order.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Isolated HVAC Equipment including (but not limited to) Air handlers, Fans, Pumps, Boilers, Chillers, Piping, Ductwork.
- B. Internally-isolated Equipment.
- C. Plumbing Equipment including (but not limited to) Pumps, Piping.
- D. Electrical Equipment including (but not limited to) Transformers, Dimmers, Buses.
- E. Concrete for equipment bases (housekeeping pads) and inertia blocks.
- F. Flexible electrical connections to motors and vibrating equipment.
- G. Flexible duct connections to fans and other vibrating elements.
- H. Pipe suspension systems, connectors and couplings.

1.3 GENERAL REQUIREMENTS FOR THE MANUFACTURER

- A. Equipment: Provide vibration isolators, base frames, inertia bases and seismic restraints of sufficient size and distribution to assure that deflection, stability and seismic restraint requirements are met. For typical units, no fewer than four isolators shall be provided. Isolators shall be provided to deflect uniformly under operating gravity and equipment thrust loadings to within  $\pm 10\%$  of specified deflection values.
- B. Specific Equipment: Specific manufacturer's equipment items are listed in this specification. All current and complete requirements from the listed manufacturer of these items shall be integral to this specification, unless such requirements conflict with requirements herein.
- C. Instructions to the Design-Builder:
  - 1. Provide written installation instructions to the Design-Builder.
  - 2. Provide a visit or visits to the jobsite before equipment is installed for the purposes of instruction. During the visit the manufacturer will inspect intended equipment locations and instruct installers in correct equipment installation procedure and sequence.
- D. Final Inspections: Provide a visit or visits to the jobsite after equipment is installed for the purposes of inspection. Identify all improperly installed vibration isolation equipment and instruct the Design-Builder in corrective work.

1.4 GENERAL REQUIREMENTS FOR THE DESIGN-BUILDER

- A. Short-Circuiting: Rigorously avoid short-circuiting to the building any vibration-isolated piece of equipment, pipe, duct or other component. Short-circuits with or via rigid conduits, drain lines, rigid braces, rigid sleeves, framing, etc. all shall be avoided. The Design-Builder shall oversee trades to prevent the short-circuiting of any vibration isolation system and shall bring any unresolved conflicts to the Campus Project Manager (CPM)'s attention.

- B. Extra Parts: Supply and install any incidental equipment or parts needed to meet the requirements stated.
- C. Package Units: Where equipment within Package Units is provided with separate isolators by the equipment manufacturer and the package enclosure is scheduled to be on an isolator assembly, the internal isolators shall be removed or permanently blocked and the isolated components they supported shall be rigidly attached to the enclosure.
- D. Post-Installation Inspection and Adjustment:
  - 1. After the installation of each item of equipment is complete and under full operational load, vibration isolators shall be adjusted so that loads are transferred to them and away from temporary blocking washers and shims. Blocks and shims then shall be removed and used as gauges to judge required clearances. Washers shall be moved away.
  - 2. Inspect all vibration-isolated equipment, coordinate the work of all involved trades, and see that vibration isolators are not short-circuited by seismic restraints, drain lines, conduits, stanchions, control tubing, duct connections, pipe connections, etc. Ensure hanger isolators and their rods or wires do not touch any other building component.
  - 3. Obtain "rough-in" inspection and approval from the Campus Project Manager (CPM)'s of any installation to be covered or enclosed, prior to such closure.
  - 4. Schedule final inspection(s) by the equipment Manufacturer after installation as required in Section 1.03.E. Obtain "rough-in" inspection by the Manufacturer of any installation to be covered or enclosed, prior to such closure.
- E. Response to Punchlists: Upon completion of the work, the Campus Project Manager (CPM)'s will carry out an inspection of the project and of final project record documents and will inform the installing contractor via punchlists of any further work that must be completed. Correct, at no additional cost to the District, all installations that are deemed defective in workmanship or materials by the Campus Project Manager (CPM).

#### 1.5 MATERIAL REQUIREMENTS

- A. Design Life: Bases, vibration isolation equipment, and seismic restraint equipment shall be capable of surviving the life of the equipment served.
  - 1. All materials, components and parts shall be new.
  - 2. All metal parts of vibration isolators to be installed out of doors shall be hot-dip galvanized after fabrication. Galvanizing shall comply with ASTM A 123, A 153, and A 386 as applicable.
- B. Springs: Springs shall be so selected and installed that the ratio of spring diameter to final compressed height shall be no less than 0.8 and no more than 1.2. Further, each spring shall have a minimum additional travel to solid equal to 50% of its actual deflection.
- C. Neoprene Elements: All elastomeric mounts, pads, bushings, sleeves, grommets, washers, etc., shall have a Shore-A hardness of 30 to 50 durometer after minimum aging of 20 days or corresponding oven-aging.
- D. Bases: For equipment that is not constructed with a base structure compatible with vibration isolation mounts, a base frame shall be supplied with the isolators. A base frame shall also be supplied where an item or equipment and its drive motor require a common rigid base.
- E. Seismic Restraints: Seismic restraints shall resist a seismic acceleration in any direction in accordance with all relevant codes without damage or deformation to equipment, building or mounts. Restraints shall not short-circuit vibration isolators during normal operation. Generally, there shall be as many seismic restraints as there are vibration isolators on a piece of equipment. Restraints and isolators shall be located close together on equipment or frames.

1.6 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

- A. Speed Limits: Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.
- B. Balancing: Rotating devices such as fans shall be balanced according to the schedule below. The following maximum velocity levels (measured in all directions at the fan bearing(s)) shall not be exceeded when the equipment is floating freely on the scheduled vibration isolators:

Equipment	Velocity, in/s (rms)
Fans	0.09
Pumps	0.13
Centrifugal Compressors	0.13

- C. Remedial Work: Should any rotating equipment cause excessive noise or vibration, the Design-Builder shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question or exceeding the above displacement values.

1.7 CONSTRUCTION SUBMITTALS

- A. Compliance: Comply with the requirements of the General Conditions Section.
- B. Specifications: Submit Manufacturer's specifications and other data needed to prove compliance with all specified requirements.
- C. Installation Instructions: Submit Manufacturer's recommended installation instructions and procedures.
  - 1. Written instructions and checklists to be delivered to the Design-Builder to aid in proper installation of manufacturer's equipment.
- D. Schedules and Shop Drawings: Submit schedules and large scale Shop Drawings clearly showing all pertinent data including, but not limited to:
  - 1. Schedule: Submit a schedule indicating tag number, location and type of all vibration isolators. This shall be sufficiently clear to suffice as a checklist and index for information outlined below.
  - 2. Design Tabulation: Submit a complete tabulation showing for each vibration isolator:
    - a. Design load.
    - b. Static deflection expected under the design load.
    - c. Specified minimum static deflection.
    - d. Additional deflection to solid under design load.
    - e. Ratio of spring height to spring diameter under design load.
  - 3. Details: Submit details of seismic restraints, steel brackets, steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, and vibration isolator and seismic restraint mounting attachment methods.
  - 4. Galvanization: Submit certified statement by the galvanizer at the time of shipment indicating that outdoor equipment conforms with all ASTM specifications.

- E. Structural Requirements: Submit the following:
  - 1. Seismic Restraint: Submit calculations by a structural engineer licensed in the state in which the building is to be erected, certifying that all seismic restraints, bolts, cables and associated components will conform with all pertinent seismic- related requirements.
  - 2. Thrust Restraint: Submit calculations for required thrust restraint of each fan. Calculations to be based on Mason Industries Data Sheet DS-207.
- F. Exceptions: Identify all proposed changes, differences and/or discrepancies, including verbiage, terms and definitions between Contract Documents and submittals.
- G. Samples: Submit samples of any or all proposed equipment at no charge to the District.
- H. Detrimental Field Conditions: Submit a list of all field conditions which the manufacturer has determined will limit the specified operational performance requirements specified for isolation devices.
- I. Contract Closeout: At completion of installation, submit the following documents. Submission of these documents must be complete before final acceptance of vibration isolation systems is given. Assistance from the vibration isolation equipment Manufacturer may be required.
  - 1. A complete tabulation showing for each vibration isolator: (a) the actual static deflection measured at the project and (b) the specified minimum static deflection.
  - 2. A report certifying a) that each piece of operative rotating mechanical equipment does not exceed the specified vibration displacement level and b) that each piece of isolated equipment or equipment component (ducts, pipes, conduit, etc.) is not short-circuited by any means and c) that the requirements of section 2.00 are satisfied for all equipment.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer's Responsibility: A single firm shall be responsible for the design, fabrication and delivery of vibration isolation equipment, including all components and seismic restraints.
- B. Manufacturer's Experience: The Manufacturer shall have successful experience in vibration isolation and seismic control equipment fabrication, including no less than five years experience in fabrication and delivery of equipment equal in quantity or complexity to this work.
- C. Structural Certification: The seismic resistance capability of all equipment shall be certified by a registered professional structural engineer in the state of California. The requirements of the California Building Code, Chapter 16A and all other applicable local codes shall be met.

#### 1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with pertinent provisions of Division 01.
- B. Protect equipment during transit, storage and handling to prevent damage and deterioration. Comply with requirements of manufacturer's instructions.
  - 1. Package equipment at factory prior to shipping using manufacturer's standard method.
- C. Identify each base or vibration isolation or seismic restraint item with individual tag numbers which correlate with the equipment tag system used on shop drawings.

1.10 WARRANTY

- A. Bases, vibration isolation equipment, and seismic restraint equipment shall be warranted against defective workmanship, operation and materials for the life of the equipment supported by these items.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason Industries Inc., Los Angeles, California Mason
- B. Kinetics Noise Control Inc., Dublin, Ohio Kinetics
- C. M. W. Saussé and Co., Valencia, California Saussé

2.2 VIBRATION ISOLATION MATERIALS

- A. Note: The listing of a Manufacturer's product in sections below does not certify that it fully complies with these specifications. All modifications of a listed product required to bring it into compliance with these specifications shall be indicated in submittals and made prior to jobsite delivery.
- B. Mount P1: Neoprene Pad(s) and Bearing Plate(s): Neoprene pad shall be ribbed or waffled, 5/16 to 1/2 inch thick, 40 durometer, with a minimum 1/16-inch-thick steel bearing plate on top. Size pad and bearing plate to receive 60 psi load. Provide single or multiple pads and plates in series as specified, with 1/16-inch-thick steel shim between layers. Provide "W + plate(s) or WM" by Mason, "NPD + plate(s) or NGD" by Kinetics or equal.
- C. Mount P2: Extra Thick Neoprene Pad(s) and Bearing Plate(s): Neoprene pad shall be waffled, 3/4 inch thick, 30 or 40 or 50 durometer, as scheduled, with a minimum 1/16-inch thick steel bearing plate on top. Pad areas shall be selected so no more than 15% and no less than 10% deflection occurs due to the supported load. Provide single or multiple pads and plates in series as specified with 1/16-inch-thick steel shim between layers. Provide "Super W + plate(s) or SWM" by Mason or equal.
- D. Mount P3: Neoprene Bushing for Bolt Holes in Pads: Bushings shall be minimum 3/16" thick in all places and maximum 40 durometer. Provide steel washer to distribute bolt head loads to bushing. Provide bushings by Mason or equal.
- E. Mount B1: Neoprene Mount: Neoprene isolators shall be double-deflection neoprene-in-shear type with steel-reinforced base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be supplied in the base and the top shall have a threaded fastener. Neoprene no harder than 50 durometer. Provide "ND" by Mason, "RD" by Kinetics or equal.
- F. Mount B2: Unhoused Spring: Springs shall be designed and installed so their ends are parallel before and after installation and during equipment operation. All mounts shall have equipment leveling bolts. Each isolator shall have a steel base plate with mounting bolt holes and a ribbed or waffled neoprene friction pad permanently adhered to the bottom. The pad shall be 5/16 to 1/2 inch thick, 40 durometer hardness, and sized for a load of 60 psi. Provide "SLFH" by Mason, or "FDS" by Kinetics or equal.
- G. Mount B2VTL: Spring with Seismic Restraint and Vertical Travel Limit: Same as Mount B2 with the addition of steel columns on either side of the spring to provide seismic restraint and accommodate vertical travel limit stops. Mount shall resist a seismic acceleration in any direction of at least 0.5 G or as required by the relevant codes. Travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the limit stops and the spring so as not to interfere with the spring action. Each isolator assembly shall have a friction pad of ribbed or waffled neoprene permanently adhered to the bottom. The pad shall be 5/16 to 1/2 inch thick, 40 durometer hardness, and sized for a load of 60 psi. Provide "SLR" by Mason, "FLS" by Kinetics or equal.



- H. Hanger H1: Neoprene Hanger: Vibration isolation hangers shall consist of a double-deflection neoprene-in-shear element contained in a steel housing. It shall be formed with a projecting neck bushing for the hole in the hanger housing that will prevent metal-to-metal contact between the hanger rod and the housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing. Neoprene shall be no harder than 50 durometer. Provide "HD" by Mason, "RH" by Kinetics or equal.
- I. Hanger H2: Standard Spring Hanger: Vibration isolation hangers shall contain a laterally-stable steel spring set in a neoprene cup manufactured with a bushing to prevent short-circuiting of the hanger rod as it passes through the hanger housing. The cup shall contain a steel washer designed to properly distribute the spring load on the neoprene and prevent its crushing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the housing. Neoprene cup shall be minimum 1/4 inch thick and maximum 50 durometer. Provide "30" by Mason or equal.
- J. Hanger H3: Pre-compressed Spring Hanger: Vibration isolation hangers shall be the same as Mount H2 but shall be delivered pre-compressed to their planned installed deflection to keep pipes or equipment steady during installation. Hangers shall be designed with a slow-release mechanism to free the spring after installation is complete and the spring is fully loaded. Great care shall be taken to see that all springs are free to oscillate 0.25". Deflection shall be clearly indicated by means of a scale. Provide "PC30" by Mason or equal.
- K. Curb C1: Standard Vibration Isolation Curb: Vibration isolation curb shall be a prefabricated assembly consisting of an extruded aluminum frame and spring vibration isolation system. The aluminum frame shall be sufficiently rigid to support the equipment load without detrimental deflection. Frame and spring connections to include resilient snubbing to resist wind and seismic forces. Spring isolators shall be selected and positioned along the two long sides of curb no closer than 7' apart to achieve the minimum static deflection called for in the schedule. The static deflection of each individual isolator shall differ from the other by no more than 10%. Galvanizing requirements shall apply to each spring used in the curbs. Provide "CMAB" by Mason, "KSR" by Kinetics or equal.

## 2.3 BASE MATERIALS

- A. Base BS1: No Frame Required for Floor Mounting: This base mounting method shall be used only with small pieces of equipment that have an integral casing or base frame that is adequately strong to be supported directly on vibration isolators without deforming the casing or frame or affecting equipment or isolator operation to any significant or noticeable extent. Place vibration isolators directly under equipment or connect steel height-saving brackets to the sides of the equipment and place isolators under brackets. Equipment manufacturer shall approve such mounting.
- B. Base BS2: Steel Frame for Floor Mounting: Steel frames for floor-mounted equipment shall consist of structural steel sections sized, spaced, and connected to form a rigid base that will not twist, rack, deform, or deflect in any manner that will negatively affect the equipment or isolation mounts. Frames shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure.
- C. Frames may be rectangular or tee-shaped in plan. The depth of steel frame base members shall be minimum one-tenth the longest dimension of the base. Frame bases shall include side-mounting height-saving brackets for attachment to vibration isolators. Provide "WF" by Mason, "SFB" by Kinetics or equal.
- D. Base BS3: Inertia Base for Floor Mounting: Concrete inertia bases for floor-mounted equipment shall be formed of stone-aggregate concrete (150 lb/cu ft) and appropriate steel reinforcing cast between perimeter structural steel sections. Inertia bases shall be built to form a rigid base that will not twist, rack, deform, deflect, or crack in any manner. Inertia bases shall be adequately sized to support basic equipment units and motors plus all attached

equipment requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base thickness shall be minimum one-twelfth the longest base dimension but not less than 8 inches. Inertia bases shall include side-mounting, height-saving brackets for attachment of vibration isolators. Minimum clearance between bottom of base and structure beneath must be either 2" or 3% of the shorter base dimension, whichever is greater. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete shall be provided and poured by the Design-Builder on site. Provide "K" by Mason, "CIB" by Kinetics or equal.

## 2.4 SEISMIC RESTRAINT MATERIALS

- A. Restraint EQR1: Floor-Mounted Restraint: Separate earthquake restraints shall be provided for all floor-mounted equipment on vibration isolation mounts that do not include seismic restraint housings. Provide a minimum of four all-directional earthquake restraints that are located as close to the vibration isolators as possible to facilitate attachment to both the equipment base and the structure. The restraints shall consist of interlocking steel members restrained by a shock-absorbent neoprene bushing. Bushing shall be a minimum of 1/4 inch thick. Restraints shall be manufactured with an air gap between hard and resilient material of 3/16 to 1/4 inch. Snubbers shall be installed with factory-set clearances. Snubber end shall be removable to allow inspection of internal clearances. Restraints shall comply with the requirements of the most recent version of the Uniform Building Code and shall resist a seismic acceleration in any direction of at least 0.5 G without damage to themselves, the building or the equipment. Provide "Z-1011 or Z-1225" by Mason or equal.
- B. Restraint EQR2: Slack Cable Restraint: Provide slightly slack steel cables of appropriate sizes and lengths and with appropriate fittings and anchorages for all isolated ceiling-suspended equipment, all isolated roof-mounted equipment, and all isolated pipes and ducts. Hanger rods shall be reinforced against upward vertical loads where required. Cable systems shall be designed to comply with the requirements of the most recent version of the Uniform Building Code and shall resist a seismic acceleration in any direction of at least 0.5 G without damage to themselves, the building or the equipment. Use seismic restraint cables as engineered and fabricated by A/B, Mason or equal.

## 2.5 THRUST RESTRAINT MATERIALS

- A. Restraint TR1: Neoprene Restraint: Thrust restraint shall be custom fabricated using a Type B1 neoprene-in-shear isolator and a steel angle. Neoprene isolator bolted to one angle leg opposes equipment thrust; second angle leg bolted to appropriate structure. The steel angle shall be sufficiently rigid and the mounting sufficiently sized and secure to resist the lateral movement of equipment during on-off cycle.
- B. Restraint TR2: Steel Spring Restraint: Thrust restraint shall consist of a spring element in series with a neoprene cup. The unit shall be designed to have the same deflection as specified for the base mountings or hangers supporting the equipment. The spring element shall be adjusted in the field to allow for a maximum of 1/4-inch movement during starting or stopping of the equipment. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor. Provide "WBI or WBD" by Mason or approved equal.

## 2.6 PIPING ISOLATION MATERIALS

- A. Connector FPC: Flexible Pipe Connectors: Flexible pipe connectors shall be fabricated of multiple plies of nylon cord, fabric, and neoprene, vulcanized so as to become inseparable and homogeneous. Straight connectors shall be formed into a double sphere shape. Elbow connectors shall have a single sphere shape at the curve of the unit. Flexible connectors shall be able to accept compressive, elongating, transverse, and angular movements.

Flexible connectors shall be selected and specially outfitted if necessary to suit the system temperature, pressure, and fluid type. Connectors for pipe sizes 2 inches and smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings. Control cables shall be provided if required. Provide "MFDEJ" or "SFDEJ" by Mason or approved equal.

- B. Anchor RPAG: Resilient Pipe Anchor or Guide: These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements that are specifically designed for providing resilient vertical and/or horizontal support when serving as a pipe anchor or guide. Minimum neoprene thickness 1/2 inch. Maximum neoprene durometer 50. Provide "ADA/GDA" by Mason, "RSF" by Kinetics or approved equal.
- C. Sleeve RPS1: Resilient Pipe Sleeve at Support or Construction Penetration: Sleeve shall consist of a formed and stiffened galvanized steel sleeve lined on the inside with moisture and vermin resistant felt bonded to the metal sleeve and 1/2 inch thick. Sleeve inside diameter shall equal pipe outside diameter in each application. Sleeve shall be split longitudinally so it can be snapped over pipes and reclosed without damage. Sleeve lengths shall be as recommended by the manufacturer for the given diameters, but shall not be less than 3 inches. Provide "PRI Isolator" by Porter-Roemer, "Trisolator" by Stoneman Engineering or approved equal.
- D. Sleeve RPS2: Resilient Pipe Sleeve at Construction Penetration: This unit shall consist of two bolted pipe halves with 3/4 inch or thicker neoprene sponge bonded to the inner faces. The seal shall be tightenable around the pipe to eliminate clearance between the inner sponge face and the piping. Sleeve shall be 2 inches longer than the thickness of the construction it penetrates. Where pipe temperatures exceed 240oF, use 10-pcf-density glass fiber insulation in lieu of sponge neoprene. Provide "SWS" by Mason, "PS-1-D" by Kinetics or approved equal.
- E. Hanger FLCH: Clevis Hanger with Felt Lining. The felt material shall be a minimum 1/4" thick and shall extend above the center-line of the suspended pipe. The felt material shall withstand a maximum temperature of 650 degrees F. The finish of the hanger shall be as specified for other clevis hangers utilized for the plumbing piping system. The isolator shall be Tolco "Clevis Hanger with Felt Lining" or approved equal.

## 2.7 FLEXIBLE DUCT CONNECTOR MATERIALS

- A. Flexible duct connectors shall be woven fiber-glass fabric material with a minimum weight of 24 oz./sq. yd. Connectors shall be minimum of 4-inches long and allow 1-inch of slack at connections. Flexible duct connectors shall have metal collar frames at each end of connections. Flexible Duct Connectors shall be Duro Dyne Durolon or equal.

## 2.8 FLEXIBLE ELECTRICAL CONNECTOR MATERIALS

- A. Make flexible electrical connections to all vibrating equipment so as to prevent any vibration transfer to the building.
  - 1. Alternate A: Employ flexible electrical conduit installed grossly slack.
  - 2. Alternate B: Employ flexible expansion/deflection conduit couplings sized for the application (1- to 6-inch diameters available). Coupling to have flexible and watertight outer jacket, inner grounding strap, flexible plastic inner sleeve to maintain smooth wire-way, and end hubs with threads to fit standard threaded metal conduit. Coupling shall be "XD Xpansion/Deflection Coupling" by Crouse-Hinds of Syracuse, New York, or "Type DF Expansion and Deflection Fitting" by Spring City Electrical Mfg. Co. of Spring City, Pennsylvania.

2.9 CUSTOM RESILIENT AND AIRTIGHT SLEEVE MATERIALS

- A. Sleeve shall be custom-fabricated. It shall be formed from pipe or sheet metal that is 1 inch larger in each cross-sectional dimension than the penetrating element and is 2 inches longer than the thickness of the construction penetrated. The annular space between the sleeve and the penetrating element shall be packed tightly with long-fiber glass fiber of 2- to 3-pcf density to within 1/2 inch of the ends of the sleeve. The remaining 1/2-inch space at each end shall be filled completely with acoustical sealant to form an airtight seal. Glass fiber packing by CertainTeed, Manville, or Owens-Corning. Acoustical Sealant by DAP, Tremco or U.S. Gypsum, choice depending on application and as approved by Campus Project Manager (CPM)'s.

2.10 SEISMIC RESTRAINT FOR DUCTWORK

- A. Ductwork shall be supported and braced to resist all directional (transverse, longitudinal and vertical) forces.
- B. Brace rectangular ducts with cross sectional areas of six square feet and larger. Brace round ducts with diameters of 28 inches and larger.
- C. Provide required bracing material.
- D. Provide one of the following options:
  - 1. Design and installation to meet the criteria listed above, and meet requirements of the latest Sheet Metal and Air Conditioning Contractors National Association (SMACNA), Seismic Restraint Manual Guidelines for Mechanical Systems for the prescribed Seismic Hazard Level (SHL) A, September 1998 with 2000 addendum 1.
  - 2. Design and installation to meet the criteria listed above, and meet the most current requirements of the National Uniform Seismic Installation Guidelines (NUSIG). Submit all design tables and information for the design force levels, stamped and signed by a California registered professional engineer.
  - 3. Where SMACNA or NUSIG requirements are not met completely, submit proposed alternate details and calculations to completely address seismic bracing requirements. Such designs shall use the California Building Code requirements for determining seismic forces, and be performed, stamped and signed by a California registered professional structural engineer.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS PRIOR TO INSTALLATION:

- A. Prior to installation of vibration isolators, frames, guides, seismic restraints and related materials, the following conditions shall be met:
  - 1. All submittals for equipment shall be approved by the Campus Project Manager (CPM)'s.
  - 2. Written and oral instructions from the vibration isolation equipment Manufacturer shall be obtained.
  - 3. Any conflicts between trades resulting in unavoidable rigid contact of vibrating equipment piping or ductwork due to inadequate space or other unforeseen conditions shall be brought to the Campus Project Manager (CPM)'s attention. If these conflicts are not resolved before installation, all corrective work shall be at the Design-Builder's expense.

4. Any discrepancies between the specifications and field conditions or any changes due to specific equipment selection shall be brought to the Campus Project Manager (CPM)'s attention. If these discrepancies are not resolved before installation, all corrective work shall be at the Design-Builder's expense.

### 3.2 GENERAL REQUIREMENTS FOR INSTALLATION

- A. Furnish and install vibration isolators, bases, seismic restraints and related materials and insure the following:
  1. No mechanical equipment or piping shall make rigid contact with the "building" unless it is approved in this specification or by the Campus Project Manager (CPM)'s. "Building" includes, but is not limited to: roofs, floors, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems. Space all vibration-isolated equipment and isolated components and all vibration isolators (including rods and wires) so as to be entirely free of any contact with any building element in any reasonable operating position.
  2. The installation or use of vibration isolators shall not cause any change of position of equipment or piping or ducts that results in stresses in any connections or misalignment of shafts or bearings. In order to meet this objective, equipment, piping, and ducts shall be maintained in a rigid position during installation. The load shall not be transferred to the isolators until the installation is complete and in operational condition.
  3. No equipment unit shall bear directly on or be suspended from vibration isolators or brackets unless its own frame or casing is suitably rigid to span between isolators without any significant or noticeable deformation and such support is approved by the manufacturer.
  4. All rigidly- or resiliently-installed equipment, piping and ducts shall be capable of resisting seismic input from the building in any direction without damaging the building, equipment or mounting system.

### 3.3 INSTALLATION OF ROOFTOP- MOUNTED EQUIPMENT

- A. Provide vibration isolation and seismic restraint for base-mounted equipment as scheduled and per all instructions in this specification.
- B. Unless otherwise shown or specified, all base-mounted equipment shall be set on 4-inch thick, hard-rock concrete housekeeping pads. Vibration isolators and seismic restraints shall be bolted to the housekeeping pad. The pad dimensions shall exceed the equipment footprint (including floor mounts) by at least 24" in each direction (i.e. 12" per side).
- C. Unless otherwise indicated, a minimum clearance of 1 inch shall be provided between the top of a housekeeping pad or floor or roof and the underside of an equipment unit or steel base frame that is vibration-isolated. The minimum clearance where a concrete inertia block is used shall be 2" or 3% of the base's smaller dimension, whichever is larger. This space shall be cleaned thoroughly of all dirt and debris.
- D. For isolation equipment (Mounts B2 and B2VTL) with neoprene pads bearing directly on structure, fasten the isolator base plates to the building structure with suitable bolts. Isolate steel bolts from steel base plates with neoprene bushings or washers and sleeves (Mount Type P3) minimum 1/4 inch thick and maximum 40 durometer hardness. Provide steel washers to distribute bolt head loads to neoprene bushings or washers below. Size bolt holes in isolator bases to account for neoprene bushings or sleeves.
- E. All bases for pumps shall be of sufficient area to support any required pipe stanchions below pipe elbows.
- F. Bases for boilers shall be of sufficient area to support draft fans, if included.

- G. Fans and pumps and their respective motors shall always be mounted on a common base.
- H. Wind loads shall be accounted for in rooftop installations, including appropriate snubbers and slack-cable restraints.
- I. Vibration isolation curbs shall be made weather-tight by sealing with flexible aluminum flashing or closed-cell neoprene or flexible vinyl all around the periphery. This weatherproofing shall in no way inhibit the vibration isolation of the spring elements. A closed-cell sponge gasket shall be provided between the equipment unit and the curb to form a weather-tight seal.

#### 3.4 INSTALLATION OF CEILING- AND ROOF-SUSPENDED EQUIPMENT

- A. Provide vibration isolation and seismic restraint for suspended equipment as scheduled and per all instructions within this specification.
- B. Ceiling- or roof-suspended equipment shall be supported from the heaviest possible structure, such as trusses, girders, beams, or joists. If necessary, provide heavy extra sub-structure between the building's existing heavy structure in order to support vibration-isolated equipment. Connect vibration isolation hangers directly to, or as close as possible to, heavy structure.
- C. Hanger rods shall be aligned and free of contact with hanger boxes.
- D. Fans and their respective motors shall always be suspended on a common, stiff frame.

#### 3.5 INSTALLATION OF SEISMIC RESTRAINTS

- A. Size, select, and install all seismic restraints so as to resist seismic forces from the building in any direction without damage to equipment, isolators, restraints, or building. Restraints shall not short-circuit vibration isolators during normal operation. Restraints shall comply with Chapter 16, Section III, Earthquake Design, in the latest version of the California Building Code and all other applicable local codes.
- B. One seismic restraint shall be provided for each vibration isolator supporting floor- or roof-top-mounted equipment, pipes or ducts.
- C. Seismic restraint cables shall be provided for all vibration isolated ceiling or roof-suspended equipment, pipes or ducts. Adjust cables with care to handle required forces but do not short circuit isolation.
- D. Hanger rods supporting ceiling or roof-suspended equipment shall be reinforced by cross-bracing or sleeves to resist lateral and upward vertical seismic loading.
- E. All vibration isolators, seismic restraints, springs with seismic restraint housings, and seismic restraint cables shall be suitably secured to appropriate structure so that the fastenings and structure can handle the seismic load.

#### 3.6 INSTALLATION OF THRUST RESTRAINTS

- A. Provide horizontal thrust restraints as scheduled for fans delivering large air quantities and with a tendency to rock back on their spring mounts. Install thrust restraints parallel to the axis of air delivery and in pairs on opposite sides of the fan.

#### 3.7 INSTALLATION OF RESILIENT DUCT SUPPORTS

- A. Provide resilient support of ducts in locations and on isolators as scheduled and/or as shown on the drawings. Provide seismic restraints for ducts and their suspension systems.

#### 3.8 INSTALLATION OF RESILIENT PIPE SUPPORTS

- A. Unless otherwise specified, provide resilient support for all HVAC and plumbing water pipes throughout the building. No such piping is to come into rigid contact with the building.

- B. Where "piping systems" are required to be vibration-isolated in a certain room or for a certain distance from an equipment unit, "piping systems" shall include all pipes, valves, strainers, tanks, converters, and other connected hardware.
- C. Support all piping in mechanical equipment rooms on Type B2 or H2 or H3 springs sized for minimum 1-inch static deflection, unless otherwise noted.
- D. Support on vibration isolators all piping outside of mechanical equipment rooms which is connected to and within a 30-foot radius of a vibration-isolated piece of equipment. If the piece of equipment is supported on neoprene isolators, support pipes on Type B1 or H1 isolators sized for minimum 0.35-inch deflection. If the piece of equipment is supported on spring isolators, support pipes on Type B2 or H2 or H3 springs sized for minimum 1-inch deflection.
- E. Throughout the rest of the building not covered in B or C above, use RPS1 resilient pipe sleeves for support. An alternate to this is 1-inch-thick, 10-pcf-density glass fiber pipe insulation with suitable bearing plates to prevent crushing of insulation and without any steel pin or other rigid connection from plate to pipe through insulation.
- F. Provide Type RPS1 or RPS2 or Custom resilient pipe sleeves wherever pipes penetrate construction.
- G. Provide Type RPAG resilient pipe anchor/guide where anchors and/or guides are required in horizontal and vertical piping. Connect RPAG units to heavy structure only.
- H. Release restraining washers and nuts in order to "free" all pre-compressed spring hangers.

### 3.9 INSTALLATION OF RESILIENT PIPE CONNECTIONS TO EQUIPMENT

- A. Piping connected to vibration-isolated equipment shall be installed so that it does not strain or force out of alignment vibration isolators supporting either the equipment or the piping. To facilitate such connection, any flexible connector approved by the Campus Project Manager (CPM)'s is acceptable.
- B. Where specifically scheduled and located, provide Type FPC flexible pipe connectors.

### 3.10 INSTALLATION OF RESILIENT DUCT CONNECTIONS TO EQUIPMENT

- A. Provide flexible connections between ducts and all vibrating equipment (including supply and return duct connections at air-handling units and fan coil units). Flexible connectors shall be minimum 4-inches long and allow 1-inch slack at connections. Use woven fiber-glass fabric material as indicated above unless loaded vinyl is specifically scheduled.
- B. Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection so that duct and opening nearly coincide and are almost equally spaced 3 inches from one another all around. Do not install flexible connection until above requirements are met. Fans or fan casings and ducts shall be able to move 1 inch in any direction relative to each other without short-circuiting metal to metal or stretching taut the flexible connection.

### 3.11 INSTALLATION OF FLEXIBLE ELECTRICAL CONNECTIONS TO EQUIPMENT

- A. Make flexible electrical connections to all vibrating equipment.
  - 1. Alternate A: Install flexible conduit in a grossly slack, shallow "U" form. Flexible conduit to be at least 3 feet or 20 diameters long, whichever is the longer.
  - 2. Alternate B: The flexible coupling shall be free of any nearby building construction and shall be installed slack and free of strain in any direction.

3.12 INSTALLATION OF RESILIENT AND AIRTIGHT SLEEVES

- A. RPS1 and PPS2 Resilient Pipe Sleeves: Observe requirements in 3.10A1 and 2 above. In lieu of packing and sealant, clamp factory-fabricated sleeve assemblies tightly around penetrating elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before sealing of sleeves to penetrated constructions.
- B. Custom Sleeves:
  - 1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below, and vertical framing between and to the sides as required. Provide the above, escutcheon plates, and anything else necessary to make the penetrated structure as solid and massive near the penetrations as away from the penetrations.
  - 2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster, or drywall compound full depth and all around--but only to a maximum width of 1 inch--or the requirements of the above paragraph shall not have been satisfied.
  - 3. Pack the 1/2-inch wide annular opening with glass fiber between metal sleeve and penetrating element full depth all around to a firm degree of compaction. Leave a 1/2-inch deep annular opening free at each end of the metal sleeve; fill this fully with acoustical sealant.

END OF SECTION



SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 WORK RELATED IN OTHER SECTIONS

- A. Section 230500: Basic Materials and Methods
- B. Section 230900: Controls and Instrumentation
- C. Section 233113: Air Distribution
- D. Division 26: Electrical.

1.3 SUMMARY

- A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 230500 -Basic Mechanical Requirements.
- B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
  - 1. Air handling systems including supply, return and exhaust.
  - 2. Air distribution ductwork including supply, return and exhaust.
  - 3. Automatic temperature control system.
  - 4. General exhaust systems.
  - 5. Domestic hot water supply and return.
  - 6. Instruction of Owner's personnel for future balancing of systems.
- C. Reference Standards
  - 1. ASHRAE-Standard 111—1988 Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.
  - 2. ASHRAE—2003 HVAC Applications Handbook: Chapter 37--Testing, Adjusting and Balancing.
  - 3. AABC—National Standards for Total System Balance.
  - 4. NEBB—Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
  - 5. SMACNA—HVAC Systems-Testing, Adjusting and Balancing.
  - 6. Sheet Metal Industry--Testing, Adjusting, Balancing Bureau (TABB) Certified Technician Standards, Procedures and Specifications.
  - 7. American National Standards Institute (ANSI): Comply with the following:
    - a. S1.4Specification for Sound Level Meters.
    - b. S1.11Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

#### 1.4 QUALITY ASSURANCE

- A. Contractors Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project.
- B. Acceptable Testing and Balancing Firms
  - 1. American Air Balance Co., Inc.
  - 2. Winaire Inc.
  - 3. San Diego Air Balance Co.
  - 4. Penn Air Control, Inc.
- C. Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.
- D. Penalty: The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.
- E. Retainages: In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.
- F. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 6 months
- G. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all deficiencies and proposed recommendations to the Owner' Representative, Contractor, Architect and Engineer.
- H. The testing and balancing agency shall provide with his bid a performance guarantee covering all phases of the work as herein specified.
- I. The General and mechanical contractors shall cooperate with the selected testing and balancing agency in the following manner:
  - 1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
  - 2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing dampers as required by testing and balancing agency.
  - 3. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
  - 4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
  - 5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.

1.5 SUBMITTALS

- A. Conform to the Submittals requirements of Division 01.
- B. Forms: The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable. Data shall include, but not be limited to, a title page with building information, instrument lists, air flows, water flows, temperatures, sound levels, capacities, nameplate data.
- C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include identification and types of instruments used, and their most recent calibration date, and key plans identifying all inlets and outlets. Final test reports shall be typed. Hand written reports are not acceptable.
- D. Maintenance Data: Include, in maintenance manuals, copies of certified test reports and identification of instruments.
- E. Qualifications: The Contractor shall submit the certified individual qualifications of all persons responsible for supervising and performing the actual work and the name of the certifying engineer. Provide a reference list of five (5) similar size projects with contact person and telephone number.

1.6 AGENDA

- A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.
  - 1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.
  - 2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating and cooling.
  - 3. The agenda shall include a list of all air and water flows to be performed at all mechanical equipment.
  - 4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas such as conference rooms.
  - 5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.
  - 6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:
    - a. Air terminal configuration.
    - b. Flow direction (supply or exhaust).
    - c. Velocity corrections.
    - d. Effective area applicable to each size and type of air terminal.
    - e. Density corrections.
  - 7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

1.7 JOB CONDITIONS

- A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
  - 1. Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.

2. Work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal states.
4. All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions.

## PART 2 - PRODUCTS

### 2.1 TEST HOLES

- A. Test holes shall be provided in ducts, housings and pipes as necessary for the proper air and water measurements and to balance systems. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

### 2.2 PATCHING MATERIALS

- A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.
  1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.
  2. Piping shall be capped with materials the same as the piping system.
  3. Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

### 2.3 TEST INSTRUMENTS

- A. Standards: Utilize instruments and equipment of type, precision, and capacity as recommended in the NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and AABC manual MN-1.
- B. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. A representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
- C. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against transfer standard instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.
- D. Cone Instruments: The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

## PART 3 - EXECUTION

### 3.1 PROCEDURES AND INSTRUMENTS, GENERAL

- A. Requirements: All systems and components thereof shall be adjusted to perform as required by drawings and specifications.

- B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.
- C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
  - 1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
  - 2. All labor, instruments, and appliances required shall be furnished by the Contractor. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

### 3.2 DUCT SMOKE DETECTORS

- A. The testing and balancing agency shall direct the placement of all duct mounted smoke detectors.
  - 1. Obtain information from the Contractor who is to furnish the smoke detectors on the proper device placement and installation limitations and on the proper differential pressure across the sampling tubes of the duct detectors.
  - 2. Based on the submitted manufacturer's installation guidelines indicate the proper mounting location to the installing Contractor.
- B. After the installation of all smoke detectors test them again in the final installation position and report differential pressures.

### 3.3 AIR SYSTEM PROCEDURES

- A. Adjustments: Adjust all air handling systems to provide approximate design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant conditions. Adjusting and balancing of all systems shall be conducted during periods of the year approximating maximum seasonal operation.
- B. Equalizers: Equalizing devices shall be adjusted to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.
- C. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).
  - 1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.
  - 2. Restriction imposed by flow regulating devices in or at terminals shall be minimal.
  - 3. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air patterns of diffusion.
- D. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 1/2-inch W.G. and sound level criteria is met.
- E. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.
  - 1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."

2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, airflow in the duct shall be determined by totaling volume of individual terminals served, measured as described herein.
  3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.
- F. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.
- G. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda. Laboratory tests shall be conducted to prove of methodology when so directed. Such tests shall be conducted in conformance with applicable ASHRAE or American Society of Mechanical Engineers (ASME) codes and shall be made at no cost.
- H. Air Motion: Air motion and distribution shall be as specified and indicated on drawings. The Contractor at no additional cost shall, in addition to air motion measurements, make smoke tests wherever requested to demonstrate the air distribution from air terminals.
- I. Air System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:
1. Test and adjust blower RPM to design requirements.
  2. Test and record motor full load amperes.
  3. Make pitot tube traverse of main supply ducts and obtain design CFM at fans.
  4. Test and record system pressures, suction and discharge.
  5. Test and adjust system for design recirculated air, CFM.
  6. Test and adjust system for design CFM outside air.
  7. Test and record entering air temperatures.
  8. Test and record leaving air temperatures.
  9. Adjust all supply, return and exhaust air ducts to proper design CFM.
  10. Adjust all zones to proper design CFM, supply and return.
  11. Test and adjust duct systems and each diffuser, grille, and/or register to within 10% of design requirements.
  12. Each grille, diffuser and register shall be identified as to location and area.
  13. Size, type and manufacturer of VAV boxes, diffusers, grilles, registers and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
  14. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustment.
  15. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Testing agency shall check all controls requiring adjustment by control installers. Room thermostats shall be checked for cooling and heating response.
  16. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
  17. Adjust overall system balances to allow all self-closing exterior doors to close from any open position. Maximum interior air pressure in a 100% outside air intake mode shall not exceed 0.05" static pressure relative to the outside air pressure.
  18. As part of the work of this contract, the HVAC contractor shall make any changes in the pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.
  19. After air balancing is completed and RPM determined, HVAC Contractor shall provide fixed pitch pulleys.

20. All mixing boxes, VAV air valves, control dampers, smoke dampers and similar devices which operate at 100% shut off shall be tested for leakage.
21. Variable Air Volume Fan Systems: The primary balancing mode is 100% outside air with all terminal boxes on a full call for cooling. Also check and record performance at minimum outside air with all terminal boxes on call for full cooling and at minimum outside air with all terminal boxes on call for full heating. Verify that the systems are operating on a stable part of the fan curves in each mode. Record final duct static controller settings.
22. Provide certification for pressurization of stairs and vestibules as required by the local codes and fire marshal.

### 3.4 AIR SYSTEM DATA

A. Report: The certified report shall include for each air handling system the data listed below.

1. Equipment (Fan or Factory Fabricated Station Unit):
  - a. Installation data
    - 1) Manufacturer and model
    - 2) Size
    - 3) Arrangement, discharge and class
    - 4) Motor hp, voltage, phase, cycles, and full load amps
    - 5) Location and local identification data
  - b. Design data
    - 1) Data listed in schedules on drawings and specifications.
  - c. Fan recorded (test) data
    - 1) cfm
    - 2) static pressure
    - 3) rpm
    - 4) motor operating amps
    - 5) motor operating bhp
2. Duct Systems:
  - a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust:
    - 1) duct size(s)
    - 2) number of pitot tube (pressure measurements)
    - 3) sum of velocity measurements (Note: Do not add pressure measurements)
    - 4) average velocity
    - 5) recorded (test) cfm
    - 6) design cfm
  - b. Individual air terminals
    - 1) terminal identification supply or exhaust, location and number designation
    - 2) type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
    - 3) design and recorded velocities - fpm (state "core," "inlet," etc., as applicable)
    - 4) design and recorded quantities - cfm (deflector vane or diffusion cone settings)

### 3.5 WATER SYSTEM PROCEDURES

- A. Preparation:
  - 1. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
  - 2. Remove all strainers and clean same. Reinstall.
  - 3. Examine water system and determine if water has been treated and cleaned.
  - 4. Check pump rotation.
  - 5. Check expansion tank to determine they are not air bound and the system is completely full of water.
  - 6. Check all air vents at high points of water systems and determine that all are installed and operating freely.
  - 7. Check operation of automatic bypass valve.
  - 8. Check and set operating temperatures of all equipment at design requirements.
  - 9. Complete air balance must have been accomplished before actual water balance begins.
- B. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component.
- C. Metering: Water quantities and pressures shall be measured with calibrated meters.
  - 1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment (coils except room units, converters, etc.) prior to the capacity testing.
  - 2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.
- D. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.
- E. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.
- F. Distribution: Adjustment of distribution shall be effected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; service valves shall not be used.
  - 1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.
- G. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.
- H. Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:
  - 1. Set chilled, heating and condenser water pumps to proper gallons per minute delivery.
  - 2. Adjust chilled water flow through chiller(s).
  - 3. Adjust heating water flow through boiler(s).
  - 4. Adjust condenser water flow through cooling tower(s).
  - 5. Test and record entering and leaving water temperatures through chillers, boilers and cooling towers.



6. Test and record water temperatures at inlet and outlet side of each terminal unit. Note rise or drop of temperatures from source.
7. Proceed to balance each terminal unit.
8. Upon completion of flow readings and adjustments at coils, mark all settings and record data.
9. After adjustments to coils are made, recheck settings at the pumps, chiller, boilers, and cooling towers and readjust if required.
10. Record and check the following items at each coil.
  - a. Inlet water temperatures.
  - b. Leaving water temperatures.
  - c. Water pressure drop of each coil.
11. Pump operating suction and discharge pressures and final total dynamic head.
12. List all mechanical specifications of pumps.
13. Rated and actual running amperage of pump motor.
14. Water metering device readings.

### 3.6 WATER SYSTEM DATA

- A. Report: The certified report for reach water system shall include the data listed below.
1. Pumps:
    - a. Installation data
      - 1) manufacturer and model
      - 2) size
      - 3) type drive
      - 4) motor hp, voltage, phase, and full load amps
    - b. Design data
      - 1) gpm
      - 2) head
      - 3) rpm and amps
    - c. Recorded data
      - 1) discharge pressures (full-flow and no-flow)
      - 2) suction pressures (full-flow and no-flow) operating head
      - 3) operating gpm (from pump curves if metering is not provided) no-load
      - 4) amps
      - 5) full-flow amps
      - 6) no-flow amps
  2. Air Heating and Cooling Equipment:
    - a. Design data
      - 1) load in Btu or MBh
      - 2) gpm
      - 3) entering and leaving water temperature
      - 4) entering and leaving air conditions (DB and WB)
      - 5) cfm
      - 6) water pressure drop
      - 7) entering steam pressure
    - b. Recorded data
      - 1) type of equipment and identification (location or number designation)
      - 2) entering and leaving air conditions (DB and WB)
      - 3) entering and leaving water temperatures

- 4) gpm (if metered)
- 5) temperature rise or drop
- 6) entering steam pressure

3. Water Chilling Units:

a. Installation data

- 1) manufacturer and model
- 2) motor hp, voltage, cycles, phase, and full load amps
- 3) part load amperes
- 4) gpm - chiller and condenser
- 5) water pressure drop - chiller and condenser
- 6) entering and leaving water temperature - chiller and condenser

b. Recorded data (chiller and condenser)

- 1) gpm
- 2) water pressure drop
- 3) entering and leaving water temperature
- 4) amperes

3.7 SOUND TEST PROCEDURES

- A. Scope: Tests of sound levels shall be made at each selection point included in the agenda.
- B. Timing: Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.
  1. Measurements shall be taken with all equipment turned off, except that being tested.
  2. The required sound levels shall be measured at any point within a room not less than 6 feet from an air terminal or room unit, and not closer than 3 feet from any floor, wall, or ceiling surface.
- C. Meters: Sound levels shall be measured with a sound meter complying with ANSI S1.4. The "A" scale shall be used to measure over all sound levels. To determine the specified octave band levels, the above sound level meter, set on "C" scale, shall be supplemented by an octave band analyzer complying with ANSI S1.11.
- D. Equipment Components: The "Equipment Component" of room sound equals LPt-C. The "Equipment Component" of room sound (noise) levels shall be determined for each of eight octave bands as follows:
  1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
  2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
  3. Calculate LPt-LPb; if this value is less than 1, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
  4. Determine "c" from the table below.

LPt-LPb (db)	c (db)
1	7
2	4
3	3
4 to 4- ½	2
5 to 5- ½	1 – ½
6 to 7- ½	1
8 to 12	½
over 12	0

### 3.8 SOUND LEVEL DATA

- A. Report: certified report shall record data on sound levels, taken at each selected location, as follows:
  - 1. Source of sound and location.
  - 2. Diagram or description of relationship of sound source to measuring instrument.
  - 3. "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
  - 4. Readings at each specified octave band frequency equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
  - 5. "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures".
  - 6. Graph showing relationship between pressure levels specified and recorded readings.
- B. Retest: Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that associated air and water quantities, as previously measured, have not been disrupted.
  - 1. Certified report shall record all sound data, and their locations, after final adjustments of air and water systems involves.

### 3.9 CERTIFIED REPORTS

- A. Submittals: Six (6) copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.
- B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.
- C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.
- D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

### 3.10 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

- A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.
  - 1. At the time of final inspection, the Contractor shall recheck, random selection of data (water and air quantities, air motion, and sound levels) recorded in the certified report. In addition, all courtrooms, auditoriums, and conference rooms shall be rechecked.
  - 2. Points and areas for recheck shall be selected by the commissioning team.
  - 3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.
  - 4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.
- B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more greater than, that recorded in the certified report listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost. Retainage time shall be based on the date of the final acceptance of the certified report.

- C. Marking of Settings: Following final acceptance of certified reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

- A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:

1. Ductwork

- a. All supply air ductwork, unless otherwise shown on drawings.
- b. All return air ductwork, unless otherwise shown on drawings.
- c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20') of air handling equipment and where otherwise shown on drawings.
- d. Outside air ductwork in return plenums, mechanical rooms and in freezing climates.
- e. Exhaust air ductwork in cold air plenums.
- f. Vapor/moisture ductwork.
- g. Insulation to protect fire rated exhaust systems

2. Piping:

- a. Heating hot water supply and return piping.
- b. Chilled water supply and return piping.
- c. Condenser water supply and return piping.
- d. Steam and condensate return piping.
- e. Heat recovery piping.
- f. Process piping.
- g. Valves, pumps, air separators, strainers and fittings in insulated piping systems.
- h. Refrigerant hot gas and suction piping.

3. Hot and cold equipment.

- a. Generator exhaust systems.

4. Plenums and equipment rooms, as noted.

- B. Types of mechanical insulation specified in this Section include the following:

1. Fiberglass pipe insulation.
2. Cellular glass pipe insulation.
3. Calcium silicate pipe insulation.
4. Flexible elastomeric closed cell insulation.
5. Fiberglass duct insulation.
6. Natural fiber duct liner.
7. Polyimide Foam Acoustic duct liner.
8. Cellular glass duct insulation.
9. Flexible unicellular duct insulation.
10. Calcium silicate duct insulation.

11. Fiberglass equipment insulation.
12. Calcium silicate equipment insulation.
13. Cellular glass equipment insulation.
14. Flexible unicellular equipment insulation.
15. Insulation jackets.
16. Insulation accessories.

### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 220501: Plumbing.
- B. Section 230500: Basic Materials and Methods.
- C. Section 232113: HVAC Piping, Valves and Specialties.

### 1.4 DEFINITIONS

- A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.
- B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
- C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
- D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
- E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
- F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
- G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
- H. Freezing Climate: Where outdoor design temperature is less than 33°F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

### 1.5 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
  1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
    - a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
    - b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
    - c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
    - d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
    - e. Properties by Means of the Guarded-Hot-Plate Apparatus.
    - f. C195 - Specification for Mineral Fiber Thermal Insulating Cement.
    - g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
    - h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
    - i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
    - j. C305 - Test for Thermal Conductivity of Pipe Insulation.
    - k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.

- l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
  - m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - n. C449 - Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - o. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  - r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
  - s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
  - t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
  - u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
  - v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
  - w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
  - x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
  - y. C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
  - z. C1071 - Standard Specification for Thermal and Acoustical Insulation.
  - aa. C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings..
  - bb. E84 - Test Method for Surface Burning Characteristics of Building Materials.
  - cc. E119 - Test for Fire Resistance.
  - dd. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
  - ee. G22 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
- 2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
    - a. 90 Energy Conservation in New Building Design.
  - 3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
    - a. 255 Test Methods, Surface Burning Characteristics of Building Materials.
- B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.
  - C. Products Containing Prohibited Chemicals:
    - 1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass:
      - a. Pentabrominated diphenyl ether (CAS#32534-81-9)
      - b. Octabrominated diphenyl ether (CAS#32536-52-0)
      - c. Decabrominated diphenyl ether (CAS#1163-19-50)

- D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.
- E. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
  - 1. Test Specimen: Two specimens shall be used, each measuring 1" by 4" by approximately ½" thick.
  - 2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1" wide, 4" long and 0.020" thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
  - 3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.
- F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

#### 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.
- B. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
  - 1. Pentabrominated diphenyl ether (CAS#32534-81-9)
  - 2. Octabrominated diphenyl ether (CAS#32536-52-0)
  - 3. Decabrominated diphenyl ether (CAS#1163-19-50)
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
- B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

### 2.2 DUCTWORK INSULATIONS

- A. Flexible Fiberglass Blanket: Johns Manville Microlite XG, formaldehyde-free Type 75 Flexible Blanket, Knauf ECOSE Duct Wrap:
1. Application: Insulation wrap for ductwork, or other HVAC systems.
  2. 'K' Value: ASTM C553-92, 0.27 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F installed full thickness.
  3. Density: 0.75 lb/cu ft.
  4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft.
  5. Installation: See Part 3 below.
- B. Rigid Fiberglass Board: Knauf ECOSE insulation board, Johns Manville Linacoustic R-300, Type II duct board:
1. Application: Lining insulation for HVAC plenums and ductwork.
  2. 'K' Value: ASTM C1071, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  3. Density: 3.0 lb/cu ft.
  4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft paper.
  5. Installation: See Part 3 below.
- C. Fiberglass Acoustic Duct Liner: Johns Manville Duct Liner PM with Anti-Microbial Treatment.
1. Application: Duct lining for acoustic or thermal purposes.
  2. 'K' Value: ASTM 1071, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  3. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."
  4. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
  5. Adhesive: UL listed waterproof type compliant with ASTM C916.
  6. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
- D. Natural Fiber (Cotton) Acoustic Duct Liner: Reflectix #HVNF, Flexible Blanket with Anti-Microbial Treatment:
1. 'K' Value: ASTM C518, 0.25 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  2. Noise Reduction Coefficient: 0.75 or higher based on "Type A mounting."
  3. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
  4. Adhesive: UL listed waterproof type compliant with ASTM C916.
  5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
- E. Polyimide Foam Acoustic Duct Liner: Evonic Industries model SOLCOUSTIC, or equal, Flexible Blanket:
1. Greenguard certified, low VOC.
  2. Polyimide foam insulation with acrylic polymer airstream coating.
  3. K' Value: ASTM C518, 0.30 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  4. R' value per inch thickness: ASTM C518, 3.3 (hr•ft<sup>2</sup>•°F) / Btu at 75°F.
  5. Density: ASTM D 3574, 0.80 lb/ft<sup>3</sup>.

6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
  7. Fungal and bacteria resistance: ASTM G 21/22, no growth.
  8. Noise Reduction Coefficient: ASTM C 423, 0.70 or higher based on "Type A mounting."
  9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
  10. Maximum operating temperature: 250 degrees F.
  11. Flame spread index: ASTM E84, less than 25
  12. Smoke developed index: ASTM E84, less than 50
  13. Adhesive: UL listed waterproof type compliant with ASTM C916.
  14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
- F. Round Duct Liner: Johns Manville (No product available) with Anti-Microbial Treatment.
1. Application: Round duct lining for acoustic or thermal purposes.
  2. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  3. Noise Reduction Coefficient: 0.70 as per ASTM C427. (Type A mounting.)
  4. Maximum Velocity: 4,000 ft/min.
- G. Hydrous Calcium Silicate: Schuller Thermo-12/Gold ASTM C533; Rigid Molded Block Insulation; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. "K" Value: 0.40 Btu•in./(hr•ft<sup>2</sup>•°F) at 300°F.
  2. Maximum Service Temperature: 1,200°F.
  3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
  4. Tie Bands: Secure blocks in places with staggered joints using ⅜" or ½" stainless steel bands on 12" centers.
- H. Field Applied Jackets (For Exterior Applications):
1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment.
  2. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
  3. Aluminum Jacket: 0.016" aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
  4. Circumferential joints shall be wide enough to provide weather-proofing jacket.
  5. Secure jacket with ⅜" or ½" stainless steel bands on 12" centers.
- I. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of ductwork
  2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
- ## 2.3 FIRE-RATED INSULATION SYSTEMS
- A. Insulation for Type I, commercial, kitchen hood exhaust ductwork. (See also Section 15880 Air Distribution referencing this Section).
- B. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C 656, Type II, Grade 6. UL tested and certified to provide a 2-hour fire rating.

1. Products:
  - a. Johns Manville;
  - b. Super Firetemp M.
- C. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
  1. Products:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
    - d. Thermal Ceramics; FireMaster Duct Wrap.
    - e. 3M; Fire Barrier Wrap 15A.
    - f. Unifrax Corporation; FyreWrap.
    - g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

## 2.4 PIPE INSULATIONS

- A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
  1. Non-Wicking:
    - a. Manufacturers:
      - 1) Johns Manville Micro-Lok plain with PVC cover Meeting ASTM C547; or FSK faced Micro-Flex (pipe sizes larger than 18")
      - 2) Knauf
      - 3) e insulation
    - b. Applications: Insulation of piping up to 18" in diameter and 3" thick insulation.
    - c. 'K' Value: 0.23 at 75°F.
    - d. Maximum Service Temperature: 850°F.
    - e. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.
  2. Wicking: Owens Corning VaporWick Meeting ASTM C547; Rigid Molded Noncombustible:
    - a. 'K' Value: 0.23 at 75°F.
    - b. Maximum Service Temperature: 850°F.
    - c. Jacket: Polymer facing with factory-applied adhesive closure to provide positive mechanical and vapor sealing of longitudinal seams.
- B. Rigid polyisocyanurate foam: HiTHERM HT-300.
  1. 'K' Value: 0.165 at 75°F (24°C)
  2. Maximum Continuous Service Temperature: 300°F.
  3. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.
- C. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold, ASTM C533; Rigid Molded Pipe:
  1. 'K' Value: 0.40 at 300°F.
  2. Maximum Service Temperature: 1,200°F.

3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
  4. Tie Wire: 16 gauge stainless steel with twisted ends on maximum 12" centers.
- D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
  2. Density: 8.0 lbs./cu. ft.
  3. Maximum Service Temperature: 900°F.
- E. Flexible Elastomeric Closed Cell Thermal Insulation: Armacel, Rubatex k-flex ECO, closed-cell, halogen free, elastomeric insulation. Comply with ASTM-C177, ASTM E 84 and UL 181.
1. 'K' Value: 0.27 at 75°F.
  2. Density: 3.0 to 6.0 lbs./cu.ft.
  3. Maximum Service Temperature: 260°F.
  4. Seal all seams and joints with contact adhesive.
- F. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
  2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
  3. Canvas Jacket: UL listed fabric, 6 oz/sq. yd. plain weave cotton, treated with dilute fire retardant lagging adhesive.
  4. Aluminum Jacket: 0.016" thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
  5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.
- G. Field Applied Jackets (For Exterior Applications):
1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
  2. Aluminum Jacket: 0.016" (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
  3. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
  4. Secure stainless steel or aluminum jackets with ¾" or ½" stainless steel bands on 12" centers.
  5. Manufacturers: Pabco, Childers, RPR, or approved equal.
- H. Removable Covers:
1. Provide removable covers on pumps, valves, air separators, vents, fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation may be required.
  2. Use of premolded fittings with PVC covers is acceptable.
  3. Use of lace-on type insulating blankets is acceptable.

## 2.5 EQUIPMENT INSULATIONS

- A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:
1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•°F) at 75°F installed full thickness.
  2. Maximum Service Temperature: 250°F.

3. Density: 0.75 lb/cu ft.
  4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- B. Rigid Fiberglass Board: Johns Manville Mat-Faced Micro-Aire Rigid Board:
1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  2. Maximum Service Temperature: 250°F.
  3. Density: 3.0 lb/cu ft.
  4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
  5. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)
- C. Rigid Fiberglass Board for High Temperature: Johns Manville 1000 Spin-Glas Meeting ASTM C612; Rigid, Noncombustible:
1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft<sup>2</sup>•°F) at 75°F.
  2. Maximum Service Temperature: 850°F.
  3. Density: 3.0 lb/cu ft.
  4. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)
- D. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
  2. Density: 8.0 lb/cu. ft.
  3. Maximum Service Temperature: 900°F.
- E. Hydrous Calcium Silicate: Johns Manville Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. 'K' Value: 0.40 at 300°F.
  2. Maximum Service Temperature: 1,200°F.
  3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1½" thickness.
  4. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12" maximum centers for large areas.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION AND PREPARATION

- A. Verify that piping and ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.
- B. Verify that all surfaces are clean, dry and free of foreign material.

### 3.2 INSTALLATION

#### A. General:

1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
  - a. Ductwork support angle or struts. To prevent crushing of low density insulation, provide separator or high density insulation at point of support. Vapor barrier to continue unbroken at point of support.

#### B. Ductwork –Insulation on the Duct Exterior:

1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive.
2. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
3. All exposed exterior metallic ductwork exposed or covered with cladding is to be built with a crown to shed moisture.
4. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
5. The insulation shall be firmly wrapped around the ducts with all joints lapped a minimum of 2". The vapor barrier shall be sealed with FSK or metallic pressure sensitive tape. Installed thickness shall not exceed 25% compression. Secure insulation with 16 gage soft annealed black or galvanized wire spaced not more than 12" on centers for straight runs of duct and 6" on centers for elbows and fittings
6. The underside of duct work 24" or greater in width shall be secured with mechanical fasteners and speed clips spaced approximately 18" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then, when required, sealed with the same tape as specified above.
7. For ductwork exposed in mechanical equipment rooms below 7' or in finished spaces, finish with Johns Manville Zeston 2000 PVC jacket or aluminum or stainless steel jacket.
8. For interior vapor/moisture duct applications, install fiberglass insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer's requirements and as required by local code authorities.
9. For exterior applications, provide insulation with a weather protection jacket.
10. For exterior vapor duct applications, install fiberglass insulation with weatherproof jacket.

#### C. Duct Liner:

1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.
2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.
3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 4,000 fpm or higher, a metal nosing must be installed in all liner leading edges.

4. Repair liner surface penetrations with UL listed adhesive.
5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

D. Piping Insulation:

1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
5. Provide insert between support shield and piping on piping 1½" diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
  - a. 1½" to 2½" pipe size 10" long
  - b. 3" to 6" pipe size 12" long
  - c. 8" to 10" pipe size 16" long
  - d. 12" and over 22" long
6. Use of metal saddles is acceptable as specified in Section 230500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
8. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.
9. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.
10. For exterior applications:
  - a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
  - b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.
11. For underground installations, install per manufacturer's written instructions and recommendations.
12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

E. Equipment Insulation:

1. See Piping Insulation above for additional requirements.
2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer's recommendations.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.3 DUCTWORK INSULATION SCHEDULE

- A. All insulation thicknesses shall meet or exceed state energy code and mechanical code requirements as noted below. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.
- B. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms uses as ducts or plenums, shall be installed, sealed, and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
1. In a space between the roof and an insulated ceiling.
  2. In a space directly under a roof with fixed vents or opening to the outside or unconditioned spaces
  3. In an unconditioned crawlspace.
  4. In other unconditioned spaces.

C. Flexible Fiberglass

	THICKNESS (inches)	FINISH	REMARKS
Supply ducts within building envelope	1-1/2	FSK	
Supply or return duct installed as exposed ductwork in the occupied space.	0		Except where noted on drawings for acoustical reasons
Return ducts within building envelope	1-1/2	FSK	
Exterior/Outside supply and return ductwork sandwiched in double wall sheet metal	2-1/2	FSK	* or a thickness resulting in compressed R value=8
Supply and return ductwork	2		



	THICKNESS (inches)	FINISH	REMARKS
located as described in 3.3.B above.			
Exhaust ducts within 10 ft. of exterior openings	2	FSK	
Exhaust ducts and ventilation equipment casing exposed to outdoor air	2	FSK	

- D. Thicknesses in the above table shall have insulation values as follows: 1-1/2" = R-6, 2" = R-8.0, 3" = R-12. Greater thicknesses are permitted to achieve identical values if space constraints allow.

- E. Rigid Fiberglass

	THICKNESS (inches)	FINISH	REMARKS
Outside air intake ducts	1-1/2	FSK	
Interior Plenums	1-1/2	FSK	
Exterior Plenums	2	FSK	
Supply, return and relief ducts in mechanical rooms and parking garages	2	FSK	
Vapor/moisture ducts installed exterior to the building envelope.	1-1/2	FSK	Provide jacketing on exterior ducts
Exterior ductwork sandwiched in double wall sheet metal	2	FSK	

- F. Duct Liner:

	THICKNESS (inches)	FINISH	REMARKS
Where indicated	1" unless otherwise noted on plans	Linacoustic	
Exterior ductwork in sandwiched in double wall sheet metal	2	Linacoustic	
Within 20' of Air Handling Unit in supply and return ducts	1	Refectix Natural Fiber	
Within 20' of Air Handling Unit in supply and return ducts	1	Solcoustic	

- G. Duct Liner (round):

	THICKNESS (inches)	FINISH	REMARKS
Where indicated	1	Spiracoustic	

### 3.4 PIPING INSULATION SCHEDULE

- A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness ½" if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

B. Fiberglass Insulation

	PIPE SIZE (inches)	THICKNESS (inches)	REMARKS
Heating water supply and return systems and fittings	Up to 1-½ 1-½ and over	1 ½ 3	
Chilled water supply and return systems and fittings. (44°F and above)	Up to 1 ½ 1 ½ and over	1 ½ 2	
Condenser water supply and return systems and fittings	All Sizes	1	
Piping exposed to freezing	All Sizes	1 ½	
H.P. steam over 60 psi (306°F +)	Up to 1-½ 1-½ and over	1 ½ 3	
M.P. steam 16-60 psi (251-305°F)	Up to 1-½ 1-½ and over	1 ½ 3	
L.P. steam 0-15 psi (201-250°F)	Up to 1-½ 1-½ and over	1 ½ 3	
Condensate return piping	All Sizes	1	
Plumbing vents within 10 feet of the exterior in freezing climates	All Sizes	1	
Misc. drains from electric water coolers, ice machines, etc.	All Sizes	1	
HW and Steam Valves	2 ½" and over	1 ½	Fiberglass and lagging

C. Elastomeric Foam (Closed Cell):

	PIPE SIZE (inches)	THICKNESS (inches)	REMARKS
Condensate drain pipes	All Sizes	1/2	
Refrigerant suction and hot-gas piping	All Sizes	3/4	Provide aluminum jacket on exterior insulated piping.
Refrigerant liquid piping	All Sizes	3/4	Provide on all piping concealed in structure and close proximity to likely human contact.

D. Cellular Glass:

	PIPE SIZE (inches)	THICKNESS (inches)	REMARKS
Chilled water supply and return systems and fittings. (40°F and above)	Up to 2 2 ½ and over	3 3	

### 3.5 EQUIPMENT INSULATION SCHEDULE

#### A. Flexible Fiberglass Blanket

	THICKNESS (inches)	REMARKS
Heat exchangers/converters	1 ½	
Expansion/Compression tanks	1 ½	
Air separators	1 ½	
Chilled water pump bodies	1 ½	
Condensate pump receivers	1	

#### B. Rigid Fiberglass Board:

	THICKNESS (inches)	REMARKS
Heating hot water pumps	2	

#### C. Flexible Elastomeric Foam (Closed Cell):

	THICKNESS (inches)	REMARKS
Cold water storage tank	1 ½	
Chilled water pump bodies	1 ½	

#### D. Calcium Silicate:

	THICKNESS (inches)	REMARKS
Engine exhaust mufflers and piping	4	Provide jacketing
Steam Condensate Receivers	2	Provide jacketing

END OF SECTION

## SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS AND CONTROLS

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this Section, as if repeated herein.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 018113, Sustainable Design Requirements
- B. Section 019113, General Commissioning Requirements
- C. All Division 23 Sections.

#### 1.03 REFERENCES

- A. USGBC:
  - 1. LEED – NC 3.0: EA Prerequisite 1, Fundamental Commissioning.
  - 2. LEED – NC 3.0: Credit 3, Enhanced Commissioning.

#### 1.04 DEFINITIONS

- A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.
- B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, DHW and lighting systems.
- C. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professional(s) or the Contractor. The CxA assists the Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.
- D. Commissioning Issue (Cx Issues): A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.
- E. Commissioning Issues List (Cx Issues List): A log maintained by the CxA listing all Deficiencies and Cx Issues documented during the commissioning process. All issues require action, correction and closure.
- F. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail.
- G. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.
- H. Commissioning Coordinator (CxC): Individual within the General Contractor firm who plans, schedules, directs and coordinates all the Trade Sub-Contractor's commissioning activities, and serves as the CxA's single point of contact for all administrative, documentation and coordination functions.
- I. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.
- J. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents. A Deficiency will be considered a Cx Issue and documented on the Cx Issues List.

- K. Functional Performance Test (FPT): A test of the dynamic function, operation and control sequences of equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, alarm, power failure, etc. The FPTs are performed using manual (direct observation) or monitoring methods.
- L. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components prior to Startup. IV process is complete when systems are ready for Startup. IV's are organized and documented under the System Readiness Checklist (SRC) forms.
- M. Monitoring: The recording of parameters (flow, current, status, pressure, etc) of equipment operation shall be completed using data-loggers or the Trending capabilities of BAS or control systems.
- N. Owner's Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.
- O. Percent Sampling: Witnessing the startup or testing of a selected fraction of the total number of identical or near-identical pieces of equipment such as VAV boxes.
- P. Pre-Functional Checks & Tests (PFC): These are various checks and tests performed on a piece of equipment or system just before, during or after the initial Startup and operation. They are performed to confirm that the equipment and individual components were installed correctly and are working properly. Examples include checking fan rotation, sensor calibration, actuator testing, and spot temperature, pressure and electrical measurements. They also include system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system test and balance and electrical equipment NETA testing. They are organized under the System Readiness Checklist (SRC) forms and must be completed prior to FPTs.
- Q. Startup: Initial starting or activating of equipment usually performed by the Trade Sub-Contractor or the Manufacturer's authorized representative.
- R. System Readiness Checklist (SRC): A summary checklist, typically one page per equipment, covering the necessary commissioning tasks and required documentation to verify that a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFC, and the Trade Sub-Contractor completed forms for these tasks are attached to the equipment specific SRC. The SRC must be completed and signed by the General Contractor prior to conducting the FPTs.
- S. TAB: Testing, Adjusting, and Balancing work on the air and water systems to ensure design flow conditions are met. Performed by the TAB Trade Sub-Contractor.
- T. Trade Sub-Contractor: Typically a subcontractor to the General Contractor who provides and installs specific building components and systems and/or provides certain services.
- U. Trending: Monitoring using the Building Automation System (BAS) or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

#### 1.05 DESCRIPTION OF WORK

- A. Systems and equipment to be commissioned:
  - 1. HVAC Systems
  - 2. Building Automation System (BAS) including HVAC Temperature Control Systems.

- B. Process related refrigeration equipment is not included in the commissioning scope of work.
- C. The work includes the completion and documentation of formal commissioning procedures by the General Contractor and Trade Sub-Contractors.
  - 1. Commissioning (Cx) is defined as the process of verifying and documenting the installation and performance of selected building systems to meet the specified design criteria and contract documents, thereby satisfying the design intent and the Owner's requirements and operational needs.
  - 2. The Design Professionals, General Contractor and Trade Sub-Contractors will provide the quality control for the design, installation, startup and checkout of the systems. The commissioning process provides review and qualitative functional testing in order to formally observe and document that the quality control efforts are successfully completed.
  - 3. Refer to Section 019113, General Commissioning Requirements for summary description of the general commissioning process and requirements.
  - 4. The Trade Sub-Contractors and the factory authorized service representatives shall be responsible for participation in the commissioning process as outlined in this specification and Section 019113 General Commissioning Requirements, and as directed by the General Contractor's Commissioning Coordinator (CxC) as overseen by the Commissioning Authority (CxA).

#### 1.06 COMMISSIONING PROCESS

##### A. Submittal Review by the CxA

- 1. The CxA will review the Trade Sub-Contractor's submittals for the appropriate systems in the commissioning scope, concurrently with the Design Team and will provide review comments to the Design Team.
- 2. The General Contractor shall provide a submittal log to the CxA for referencing requested submittals to be reviewed by the CxA (for which the General Contractor shall issue to the CxA concurrently with the submission to the Design Professionals). Alternatively, the General Contractor shall include the CxA on the distribution of all Trade Sub-Contractor submittals issued to the Design Professionals, for systems applicable to this specification.
- 3. The General Contractor shall ensure that the requested submittals for review by the CxA are issued to the CxA at the same time they are issued to the Design Team.
- 4. Information from the submittals will also be used by the CxA to develop commissioning forms and test procedures.

##### B. Cx Plan and Form Development

- 1. The CxA prepares a Preliminary Cx Plan during the project final design phase. The Cx Plan provides guidance in the execution of the commissioning process during construction.
- 2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the commissioning process and systems are reviewed. The Preliminary Cx Plan is presented and specific requirements and responsibilities are discussed and implemented.
- 3. The CxA develops the SRC forms which list and track the completion of the Installation Verification, Startup, and Pre-Functional Checks & Tests required for each system and equipment to be commissioned. The SRC forms are provided to the General Contractor and Trade Sub-Contractors for review and comment.

4. The CxC shall submit to the CxA, for review and approval, representative blank forms for completing Installation Verification, Startup, and Pre-Functional Checks & Tests.
  - a. Installation Verification forms are used to provide field verification and documentation of proper installation of equipment and system prior to formal Startup. Where appropriate, these forms may be combined with the Startup and Pre-functional Check & Test forms. And where appropriate, these forms can be checklists taken from the Manufacturer's installation manual.
  - b. Startup and Pre-Functional Check forms primarily consist of Manufacturer and Trade Sub-Contractor startup and checkout sheets and shall be used where required and appropriate. Where applicable, these forms shall include checks of the equipment controls including sensors and control devices.
  - c. The Pre-Functional Test forms shall also include forms for recording results from system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system TAB, electrical equipment NETA testing, etc.
5. The CxA will develop FPT procedures and forms. These test procedures are provided to the General Contractor and Trade Sub-Contractors for review and comment.
6. The CxA will update and finalize the Cx Plan with equipment specific documentation and SRC and FPT forms.

C. System Readiness Activities

1. Meetings will be conducted throughout construction with Commissioning Team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx Issues.
2. The Trade Sub-Contractors shall perform Installation Verification, Startup and Pre-Functional Check & Test activities, as part of the system readiness checks to verify that the system is ready for operation or functional testing. The Trade Sub-Contractors and the CxC shall document completion of these activities on the SRC forms and attach the completed Installation Verification, Startup, and Pre-Functional Check & Test forms to the SRC.
  - a. In general, Installation Verification should be completed prior to Startup, but where appropriate, they can be completed into one activity.
3. The CxA will perform various observation inspections during the installation phase and back-checks of the completed Installation Verification. The CxA will also witness a percent sampling of the Startups and Pre-Functional Checks & Tests, including TAB procedures.

D. Functional Testing

1. Functional Performance Tests (FPTs) are tests of the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests are used to verify that the sequences of operation are correctly implemented and that the design intent criteria and performance of the systems have been met.
2. The CxA will develop FPT forms that contain:
  - a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.
  - b. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.

- c. A section for recording actual system response, notes and comments.
  - d. Any definitions of control system trend data to be collected and provided to the CxA in electronic format for analysis and review.
3. Once the SRC forms are completed, the FPTs are executed by the Trade Sub-Contractors and a sample are witnessed by the CxA, as defined in the Cx Plan. The FPTs may be achieved by any combination of manual testing, monitoring or trending.
  4. Any deferred testing will be defined in the Cx Plan.
- E. Deficiencies and Commissioning Issues
1. Throughout the process, the Commissioning Issues are recorded by the CxA on the Commissioning Issues List and distributed to the commissioning team. The General Contractor and Trade Sub-Contractors shall correct Commissioning Issues and retest the system(s), where applicable, without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and make all amendments to the issues list.
- F. O&M Manuals, Training Verification and Final Documentation
1. The General Contractor shall compile and complete the Operations & Maintenance (O&M) Manuals provided by the Trade Sub-Contractors, per the contract documents requirements. The CxA will verify that the O&M manuals have been delivered to the Owner per the contract requirements and may request electronic copies of the O&M Manuals to aid in the completion of the Systems Manual.
  2. The General Contractor shall submit a training schedule and specific training agendas provided by the Trade Sub-Contractors for each training class, to the CxA and Owner for review prior to conducting any training. The CxA will review and provide comment to the Owner and General Contractor on the specified training agendas. The CxA will verify completion of the training by receiving a copy of the training sign-in sheets, provided by the General Contractor.
  3. The CxA will develop the Systems Manual (for energy-related systems per LEED requirements) with assistance from the General Contractor and Trade Sub-Contractors. The systems to be included are the HVAC systems and controls, lighting controls, domestic hot water systems and controls, and any renewable energy systems.
  4. The CxA will complete the Final Construction Phase Commissioning Report and documentation for the Owner with assistance from the General Contractor and Trade Sub-Contractors.
- G. Post-Occupancy Warranty Phase Commissioning
1. No later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.
  2. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period.



1.07 COMMISSIONING TEAM

- A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:
  - 1. Owner and Owner's Representatives
  - 2. Design Professionals (DP)
  - 3. Commissioning Authority (CxA).
  - 4. General Contractor
  - 5. General Contractor's Commissioning Coordinator (CxC)
  - 6. Trade Sub-Contractors responsible for systems covered in this section include:
    - a. Mechanical Contractor
    - b. BAS / HVAC Controls Contractor
    - c. TAB Contractor

1.08 RESPONSIBILITIES

- A. General.
  - 1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.
- B. Commissioning Authority (CxA)
  - 1. See Section 01 91 13, General Commissioning Requirements.
- C. General Contractor:
  - 1. See Section 01 91 13, General Commissioning Requirements.
- D. Trade Sub-Contractors – General Requirements:
  - 1. Provide commissioning submittal data, including manufacturer's installation checks and startup procedures, commissioning forms, and any other requested contract documentation for systems to be commissioned. Electronic files are acceptable.
  - 2. Attend commissioning meetings as directed by the CxA and General Contractor's CxC to facilitate the commissioning process.
  - 3. Assign personnel with expertise and authority to act on behalf of the General Contractor and schedule them to participate in and perform assigned commissioning tasks.
  - 4. Demonstrate and document proper system installation, startup and performance. Complete all Installation Verification, Startup and Pre-Functional Check & Test documentation clearly and legibly. Provide a copy of all forms to the CxC and CxA as part of completing the SRC forms.
  - 5. Provide access for the CxA to witness any equipment Startup and Pre-Functional Checks & Tests. Notify the CxC and CxA at least 10 days in advance of Startup and Pre-Functional Checks & Tests.
  - 6. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.
  - 7. Ensure that any required manufacturer's representative field tests and on-site installation verification, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.

8. Address Trade Sub-Contractor applicable Cx Issues and Deficiencies promptly. All Installation Verification, Startup and Pre-Functional issues must be resolved before the FPT can proceed.
9. Assist CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.
10. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits and overrides to be used during the tests.
11. As part of the FPTs, the Trade Sub-Contractor shall setup any additional software points, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs.
12. Perform the FPTs. Execution of FPTs shall be witnessed by the CxC and CxA and fully documented.
13. Assist the CxA in collecting all requested Trend data associated with FPTs.
14. Prepare a training agenda for each training class (to be reviewed by the CxA) and work with the General Contractor and Owner to schedule training. Execute training of Owner's personnel per approved training agenda and schedule.
15. Prepare O&M Manuals according to the Contract Documents.
16. Assist the CxA in developing the Systems Manual.

E. Trade Sub-Contractors – Specific HVAC System Control Requirements

1. In addition to the general Trade Sub-Contractor responsibilities outlined above, the BAS Trade Sub-Contractor responsibilities during commissioning shall include, but are not limited to:
  - a. Prior to any controls construction activity, provide approved submittals, including shop drawings, control drawings, points list and detailed sequences of operation for each piece of equipment and system to be controlled. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings. Electronic files are acceptable.
  - b. Provide a complete control points list in MS Excel or other pre-approved format. Points list shall include point name, point description, display units (i.e. degrees F, percent, psi), panel identification, point type (AI, AO, BI, BO, virtual/software), field device controlled (through network, dry contact, actuator limit switch or other specific equipment), BAS application or energy management function associated with point, and associated alarm points and parameters, etc. The BAS Trade Sub-Contractor shall make all points available for continuous trending.
  - c. Provide control system diagrams showing all control points, sensor locations, actuators, and controllers.
  - d. Provide a list of test metering and sensors to be used for calibration purposes. The list shall include test meter and sensor accuracy for comparison to the BAS sensor accuracy requirements specified in contract documents. And all test meter and sensors shall have been calibrated within a year and have calibration documentation.

- e. The control system installation verification and pre-functional checks (and associated documentation) shall include checking sensor installation; program setup check (point type, range/scale, etc.); point-to-point checks; sensor calibration or checks; and actuator checks. At a minimum, the actuators shall be physically checked at full open (100% open), half-open (50% open) and full close positions (0% open). For the sensor checks, each analog input sensor reading on the BAS shall be checked against a hand-held sensor of equal accuracy for verification purposes.
  - f. The FPTs will include an integrated whole building test under emergency power. This test is initiated by disconnecting the utility power to the building, and it will involve multiple disciplines. All Trade Sub-Contractors shall participate in the FPTs as required for operation of the inter-related systems.
  - g. The BAS Trade Sub-Contractor shall set up the appropriate Trends per the final FPT forms provided by the CxA and shall provide trend data into a usable electronic format, such as a text, CSV or Excel format to the CxA. The CxA will analyze and review the trend data as part of the FPT.
    - 1) The trend points list may include both hardware (inputs, outputs) and virtual / software points. The appropriate trend intervals and minimum duration will be provided on the FPT forms.
    - 2) As an Owner approved alternative, the BAS Trade Sub-Contractor may provide the CxA remote access to the control system, with Owner permission, that will allow the CxA to directly download the Trend data.
  - h. The BAS Trade Sub-Contractor shall also provide trend data to the CxA during the post-occupancy warranty phase for review by the CxA, where required.
2. In addition to the Trade Sub-Contractor responsibilities outlined above, the TAB Trade Sub-Contractor responsibilities during commissioning shall include, but are not limited to:
- a. As part of developing the submittal requirements for commissioning, and prior to conducting any TAB work, provide a TAB Plan that outlines the TAB procedures and approach for each system type along with the associated forms and drawings to be used in the TAB work. Additionally the TAB Plan shall include any TAB qualification certificates and TAB device calibration certificates. The TAB Plan and certificates shall be submitted to the Design Professional and CxA for review, in addition to any other submittal requirements per Section 230593. Electronic files are acceptable.
  - b. Provide access for the CxA to witness TAB work. Notify the CxC and CxA at least 10 days in advance of TAB work.
    - 1) Immediately report any Deficiencies discovered which may affect or delay the commissioning process.
  - c. Submit a Draft Field TAB Report with the completed field forms and data to the Design Professional (DP) and CxA for review, within 72 hours following completion of the TAB activities, and prior to any TAB field inspections and verification work conducted with the DP and/or the CxA.
  - d. The TAB Trade Contractor shall support commissioning by participating in the commissioning TAB Field Review, in which the TAB Trade Contractor demonstrates specified results to the CxA, after completion of the Draft Field TAB Report.

- 1) The TAB Field Review shall include field demonstrations of any final fan and pump pressure setpoints and back-check measurements of the air-side and water-side systems, performed by the TAB Trade Contractor and witnessed by the CxA and/or the DP, for a random 10% sampling. The TAB Field Review back-check measurements shall be recorded on the Final TAB Report for documentation purposes.
- e. Submit the Final TAB Report to the DP and CxA for review after completion of the Draft Field TAB Report review.

#### 1.09 SUBMITTAL REQUIREMENTS FOR COMMISSIONING

- A. The Trade Sub-Contractors shall submit to the CxA representative, blank forms for Installation Verification, Startup and Pre-Functional Checks & Tests.
  1. The CxA will review these submitted commissioning forms for completeness including any project specific requirements.
  2. The CxA may request additional data, changes and/or additions to these forms to make sure they are complete prior to their use. If the submitted forms are not available or are not sufficient, then the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.
- B. The Trade Sub-Contractors shall submit to the CxA any equipment and construction submittals and shop drawings, including detailed sequences of operation, as requested by the CxA.

### PART 2 -PRODUCTS

#### 2.01 DOCUMENTATION

- A. The Trade Sub-Contractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.
- B. The Trade Sub-Contractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc. , whether specified or not in the commissioning sections.

#### 2.02 TEST EQUIPMENT

- A. The Trade Sub-Contractor shall provide all test equipment to execute Pre-Functional and Functional Performance Tests.
- B. The test equipment shall be provided in sufficient quantities to execute testing in an expedient fashion.
- C. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents. If not otherwise specified, the following minimum requirements apply:
  1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degree F and a resolution to + or – 0.1 degree F.
  2. Pressure sensors shall have an accuracy of + or – 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.
- D. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.

### PART 3 - EXECUTION

#### 3.01 SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS

- A. All tests and start-up procedures shall be conducted without compromise to human or equipment safety. The General Contractor and Trade Sub- Contractors shall be responsible for the liability and safety of conducting all tests and startup.
- B. The General Contractor shall clearly identify and list any Deficiencies resulting from the Installation Verification, Start-up and Pre-Functional Checks & Tests on the associated forms and immediately notify the CxA. Once Deficiencies are corrected and verified or tested, update and resubmit the associated forms.
- C. The CxC and Trade Sub-Contractors shall a minimum 10 day's notice to the CxA for witnessing equipment Start-ups and Pre-Functional Checks & Tests.

#### 3.02 FUNCTIONAL PERFORMANCE TESTS

- A. Functional testing shall be performed and documented for 100% of all equipment in the scope of commissioning. At the discretion of the CxA and per the approved Cx Plan, the CxA may witness a percentage (sample) of the functional tests for selected, multiple identical pieces of non-life-safety or non-critical equipment (example: VAV boxes).
- B. The General Contractor and Trade Sub-Contractors shall be responsible for the liability and safety of conducting all tests.
- C. Ensure the following are completed prior to the start of the FPTs:
  - 1. Certify through the System Readiness Checklist (SRC) forms that the HVAC systems, controls and instrumentation, equipment and assemblies have been installed, calibrated, started and are operating per the Contract Documents. Approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.
  - 2. As part of the system readiness, the TAB Trade Contractor shall conduct and complete all testing, reporting, field inspection and verification work, and discrepancies and corrective work, per Section 230593, prior to HVAC system FPT.
  - 3. As part of the system readiness, all pipe system cleaning, flushing, and pressure testing, duct leakage testing and duct cleaning per the Contract Documents is completed and applicable plans and reports are provided to the CxA.
  - 4. As part of the system readiness, the BAS Controls Trade Contractor shall complete the BAS pre-functional checks and tests, including sensor calibration, actuator testing, and point-to-point checks, prior to FPTs of the HVAC systems.
  - 5. And the BAS graphics and programming for the sequence of operations and associated setpoints, schedules, and alarms shall be configured and the system operation checked and confirmed, including the control loop tuning, prior to starting functional testing.
    - a. Prior to conducting the FPTs, place the systems and controls into the operating modes to be tested (e.g., normal occupied mode, normal startup and shutdown modes, unoccupied modes including after-hours override and night setback operation, emergency power, etc.).
    - b. Check all control system safety cutouts, alarms, and interlocks with smoke control and fire-life safety during each mode of operation prior to functional testing.
- D. Trade Sub-Contractors shall execute all FPTs per the approved test procedures on the FPT forms. All testing results shall be documented on the final FPT forms; the forms shall be signed and dated by the representative performing the tests. Off hours or weekend work may be required to complete the FPTs.

- E. The CxC and Trade Sub-Contractors shall coordinate all FPT with the CxA, and provide a minimum of 10 day's notice prior to conducting each system test.
- F. FPT for each system must be successfully completed and signed by the CxA prior to formal approval of system commissioning.
- G. FPT may be conducted using these approved test methods:
  - 1. Manually manipulating the equipment settings to observe performance.
  - 2. Overwriting control system sensor values to simulate a condition, such as overwriting the outside air temperature to be something other than it actually is.
  - 3. Altering setpoints to force equipment into a mode of operation to verify a sequence. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, a FPT would temporarily change the lockout setpoint to be 2F below the current outside air temperature.
  - 4. Using indirect indicators, such as readings from a control system screen reporting a damper is 100 percent open, for testing responses will be allowed only after the actual conditions represented by the indirect indicators have been directly verified, calibrated and documented on the SRC forms (as a pre-functional check/test).
  - 5. Monitoring performance by analyzing the control system Trend data. The CxA will analyze the control system Trend data.
- H. Setup:
  - 1. The Trade Sub-Contractor executing the test shall document the pre-test normal condition on the test form.
  - 2. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible.
  - 3. The Trade Sub-Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. to execute the test according to the test procedures.
  - 4. At completion of the test, the Trade Sub-Contractor shall return all affected building equipment and systems to their pre-test normal condition.

### 3.03 FUNCTIONAL PERFORMANCE TESTS – TREND ANALYSIS

- A. The CxA will prepare a BAS Trend analysis test with a points list and trend interval, as part of the FPTs in the Final Cx Plan, to verify integrated system operation and performance. The Trend analysis test will be conducted after the FPTs for the HVAC control sequences and operating modes are completed and any issues and deficiencies are corrected.
- B. The BAS Trade Contractor shall set up the trend log definitions. Trend data shall be provided by the BAS Trade Contractor to the CxA in an electronic format, either a text file, CSV file or Excel file, with related system parameters grouped together.
- C. If performance issues are found through the Trend analysis, the issues shall be corrected by the BAS Trade Contractor and the trending shall be restarted.

### 3.04 COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTING

- A. All Deficiencies and Issues shall be documented on the appropriate forms in use, and will additionally be documented by the CxA on a Cx Issues List.
- B. Immediate correction of minor Deficiencies identified during testing may be allowed at the discretion of the CxA. In such cases the Deficiency and identified resolution must still be documented on the commissioning form in use.

- C. When Cx Issues are identified during FPT, the CxA will discuss with the executing Trade Sub-Contractor and/or CxC and determine whether testing can proceed or be suspended. The Commissioning Issue and any identified resolution will be documented on the test form in use in addition to the Commissioning Issues List.
- D. The CxA will maintain and update the Commissioning Issues List, and document the issues resolution process. Copies will be distributed to the General Contractor, Owner, and Trade Sub-Contractors as appropriate.
- E. All Deficiencies and Commissioning Issues shall be corrected promptly. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date. The CxA will record completion on the Commissioning Issues List once the issue is successfully back-checked or verified and the CxC shall reschedule testing with the CxA and Trade Sub-Contractor. Testing shall be repeated until passing performance is achieved or the Owner accepts the noted issue.
- F. When there is a dispute regarding a Cx Issue, whether it is valid or who is responsible, additional parties may be brought into the discussion as appropriate. The CxA will have the final interpretive authority on Cx Issues and Deficiencies and the Owner will have the final approval authority.
- G. The CxA may recommend solutions to Deficiencies and Commissioning Issues. However, the burden of responsibility to solve, correct and perform required retests is with the General Contractor, Trade Sub-Contractors, and the Design Professional(s).
- H. Additional Back-check Verifications and Re-testing:
  - 1. For all Commissioning Issues identified during the pre-functional system readiness activities, the CxA will back-check and verify the completion of the issues where appropriate.
  - 2. For all Commissioning Issues identified during FPT, retesting is required to verify the resolution of the issue and to complete the FPT.
  - 3. The CxA will witness one re-test for each equipment and will perform one back-check verification of any completed system readiness issue. The Owner may back-charge the General Contractor for any additional fees from the CxA, resulting from any re-testing or repeated system readiness issues list back-checks beyond the first re-test or back-check.
  - 4. A minimum 48 hour's notice is required for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.
  - 5. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension.
- I. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

### 3.05 DEFERRED & SEASONAL TESTING

- A. Before or during the end of the first year Warranty Period, any Seasonal or Deferred Testing as defined in the Cx Plan, shall be completed as part of this contract. Tests shall be conducted by the Trade Sub-Contractor responsible for the equipment and systems, completed in the same manner as all other commissioning tests, and shall be witnessed by the CxA.
- B. The General Contractor shall coordinate with CxA and Owner and schedule all Deferred and Seasonal Testing.
- C. The General Contractor shall make final adjustments to the as-built documentation or drawings for any modifications made during Deferred or Seasonal Testing.

3.06 O&M MANUAL AND TRAINING VERIFICATION

- A. The General Contractor and the CxC shall coordinate and schedule the training for Owner Personnel. The CxC shall ensure that training is completed per the requirements of the construction documents and specifications.
- B. Trade Sub-Contractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned, no less than 14 days prior to start of training. The General Contractor shall submit the training agendas to CxA and Owner for review and approval. The training agendas shall cover the following elements:
  - 1. Equipment and/or systems included in training
  - 2. Intended audience
  - 3. Location of training
  - 4. Subjects covered (including a brief description and duration, presentation methods, etc.)
  - 5. Instructor's name and qualifications
  - 6. Copy of any handout materials or presentations.
- C. The CxA will review the training plans to verify compliance with the specifications.
- D. The General Contractor shall submit to CxA 'attendee signed' attendance sheets for each training session conducted and a copy of the final training presentations.
- E. The CxA will verify with the Owner that the final O&M manuals have been delivered per the Contract Documents.

3.07 COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

- A. Completion of the main commissioning activities (system readiness checks, functional testing, training, and delivery of O&M manuals) shall be accomplished as a prerequisite for substantial completion. Completion of all commissioning issues and any re-testing shall be completed prior to final acceptance of commissioning.
- B. After completion of the commissioning activities and following review of the completed commissioning documents that includes the draft Cx Report executive summary, all test results and the latest Cx Issues List with all remaining commissioning issues and deficiencies, the Owner will provide a formal written acceptance of the project construction phase commissioning. At that point, any remaining construction phase commissioning issues or seasonal/deferred testing will be transferred to the warranty phase and tracked by the CxA as part of the LEED Post-Occupancy Warranty Phase Commissioning.
- C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Final Commissioning Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all General Contractor and Trade Sub-Contractor commissioning documentation.
- D. The Owner's written acceptance of construction phase commissioning will be included in the Final Commissioning Report.
- E. The CxA will complete a LEED Systems Manual for the systems and equipment commissioned, with assistance provided by the CxC and Trade Sub-Contractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:
  - 1. Final version of the BOD and systems narrative.
  - 2. Systems single line diagrams or schematics.



3. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.
4. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, lighting controls, etc.
5. Recommended schedule of major maintenance requirements and frequency, if not already included in the project O&M Manuals.
  - a. A summary of the preventative maintenance and service procedures is recommended in the Systems Manual, for the major MEP equipment, including a schedule matrix checklist (checked as weekly, monthly, quarterly, annually, etc.).
  - b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
  - c. Recommended schedule for calibrating sensors and actuators.

3.08 POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

- A. Per the LEED Enhanced Commissioning requirements, no later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility staff, walk the facility and review systems operation to identify any issues. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.
- B. The CxA will also review BAS trend data during the Post-Occupancy Warranty Phase. The BAS Trade Contractor will be responsible for providing post-occupancy trend data to the CxA.
- C. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period. The CxC shall work with the Trade Sub-Contractors and O&M staff to make corrections and modifications as required.
- D. After correcting noted Warranty Phase Cx Issues, the General Contractor shall notify the CxA in writing, and the CxA will back-check and verify that the Warranty Phase Cx Issue was resolved.
- E. Issues identified during the warranty period will remain Warranty Phase Cx Issues until satisfactory completion by General Contractor and back-check verification by CxA, even if the warranty period expires during the correction and back-check period.

END OF SECTION

## SECTION 23 23 00 - REFRIGERANT PIPING SYSTEMS

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 SCOPE

- A. Includes, but not limited to:
  - 1. Furnish and install piping and piping specialties for refrigeration systems serving split system air conditioning units.

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic Materials and Methods
- B. Section 230700: Mechanical Insulation
- C. Section 238126: Split Gas Furnace/Air Conditioning Units
- D. Section 238145: Split Heat Pump Units
- E. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Qualifications: A refrigeration contractor licensed by the State shall install refrigerant piping.
- B. All works and materials related to refrigeration must comply with 2007 CMC Chapter 11 and 2007 CFC Section 606.

### PART 2 - PRODUCTS

#### 2.1 REFRIGERANT PIPING

- A. Meet requirements of ASTM B 280-88, "Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service", hard drawn straight lengths.
- B. Do not use pre-charged refrigerant lines more than 50 feet in length..

#### 2.2 REFRIGERANT FITTINGS

- A. Wrought copper with long radius elbows.
- B. Approved Manufacturers:
  - 1. Mueller Streamline
  - 2. Nibco, Inc.
  - 3. Grinnell
  - 4. Elkhart Products Corp.

## 2.3 SUCTION LINE TRAPS

- A. Manufactured standard one-piece traps.

## 2.4 CONNECTION MATERIAL

- A. Brazing Rods:

1. Copper to Copper Connections:
  - a. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
  - b. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
2. Copper to Brass or Copper to Steel Connections
  - a. AWS Classification BAg-5 Silver (45% silver)
3. Do not use rods containing Cadmium.

## 2.5 FLUX

- A. Approved Manufacturers

1. "Stay-Silv white brazing flux" by J.W. Harris Co.
2. High quality silver solder flux by Handy & Harmon.

## 2.6 EXPANSION VALVES

- A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
- B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
- C. Approved Manufacturers:
  1. Alco
  2. Henry
  3. Mueller
  4. Parker
  5. Singer
  6. Sporlan

## 2.7 FILTER-DRIER

- A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with non-ferrous casing and Schraeder type valve.
- B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
- C. Size shall be full line size.
- D. Approved Manufacturers:
  1. Alco
  2. Mueller
  3. Parker
  4. Sporlan
  5. Virginia

2.8 SIGHT GLASS

- A. Combination moisture and liquid indicator with protection cap.
- B. Sight glass shall be full line size.
- C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.
- D. Approved Manufacturers:
  - 1. Alco
  - 2. Asco
  - 3. Mueller
  - 4. Parker
  - 5. Sporlan

2.9 MANUAL REFRIGERANT SHUT-OFF VALVE

- A. Ball valves designed for refrigeration service and full line size.
- B. Valve shall have cap seals.
- C. Valves with hand wheels are not acceptable.
- D. Provide service valve on each liquid and suction line at compressor.
- E. If service valves come as integral part of condensing unit, additional service valves shall not be required.
- F. Approved Manufacturers:
  - 1. CoBraCo (Apollo)
  - 2. Henry
  - 3. Mueller
  - 4. Superior
  - 5. Virginia

2.10 FLEXIBLE CONNECTORS

- A. Provide each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons.
- B. Anchor pipe near each flexible connector.
- C. Connectors shall be for refrigerant service with bronze seamless corrugated hose and bronze braiding.
- D. Approved Manufacturers:
  - 1. Anaconda "Vibration Eliminators" by Anamet
  - 2. Vibration Absorber Model VAF by Packless Industries
  - 3. Vibration Absorbers by Superior Valve Co.
  - 4. Style "BF" Spring-flex refrigerant connectors by Vibration Mountings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Slope suction lines down toward compressor or one inch/10 feet. Locate traps at vertical rises against flow in suction lines.
- B. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
  - 1. No soft solder (tin, lead, antimony) connections will be allowed in system.
  - 2. Braze valve, sight glass, and flexible connections.

3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.
- C. Insulate all suction and hot gas lines. Insulate liquid lines where pipe may be in close contact to humans.

### 3.2 FIELD QUALITY CONTROL

- A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping system. Positive pressure test will not suffice for procedure outlined below:
  1. Draw vacuum on each entire system with vacuum pump to 200 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
  2. Break vacuum with refrigerant to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
  3. Conduct test at 70°F ambient temperature minimum.
  4. Do not use systems until tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
  5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.
  6. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlets at same end of coil

END OF SECTION

## SECTION 23 31 13 - AIR DISTRIBUTION

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
  - 1. Ductwork – Rigid and Flexible
  - 2. Ductwork Specialties
  - 3. Flexible Connections
  - 4. Sealants, Adhesives and Tapes
  - 5. Flashings
  - 6. Bird Screens
  - 7. Duct Access Panels and Doors
  - 8. Control Dampers
  - 9. Backdraft Dampers
  - 10. Louvers
  - 11. Diffusers, Grilles, and Registers
  - 12. Fire and Smoke Dampers
  - 13. Variable Air Volume (VAV) Terminal Units

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230700: Mechanical Insulation
- D. Section 230900: Controls and Instrumentation
- E. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Provide products conforming to the requirements of the following:
  - 1. ARI 885-98 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets."
  - 2. AMCA-210 - Laboratory Methods of Testing Fans for Rating Purposes.
  - 3. ANSI S1.23 - Designation of Sound Power Emitted by Machinery and Equipment.
  - 4. ASC-A7001 - Standard for Duct Sealants.
  - 5. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip. Type 304 or 304 stainless steel.
  - 6. ASTM A525 - Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) Hot-Dip Process. G90 zinc-coated.
  - 7. ASTM A527/A527M - Standard Specification for Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
  - 8. TIMA AAC-101 - Standard for fiberglass duct liner with erosion proof facing.
  - 9. UL 181 - Factory-Made Air Ducts and Connections, Class 1.

- B. Conform to NFPA 90A "Standards for the Installation of Air Conditioning and Ventilating Systems".
- C. Provide and construct ductwork systems in conformance with the latest editions of the following documents:
  - 1. SMACNA "HVAC Duct Construction Standards-Metal and Flexible - 1995" (HDCS)
  - 2. [COMMENT1]SMACNA "Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" W.G. positive pressure or below -5" W.G. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards
  - 3. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter
  - 4. ASHRAE Fundamentals Handbook "Duct Design" chapter
- D. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.
  - 1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.
  - 2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.
- E. All ductwork and equipment shall be seismically supported and braced per the SMACNA "Seismic Restraint Manual: Guidelines for Mechanical Systems".
- F. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenum shall have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

## 1.5 SUBMITTALS

- A. Prior to construction, submit for approval on all materials and equipment:
  - 1. Ductwork – Rigid and Flexible
  - 2. Flexible Connections
  - 3. Sealants, Adhesives and Tapes and calculated leakage estimate based on Class 3 (3 cfm/sq.ft). leakage.
  - 4. Flashings
  - 5. Bird Screens
  - 6. Duct Access Panels and Doors
  - 7. Backdraft Dampers
  - 8. Control Dampers
  - 9. Diffusers, Grilles, and Registers
  - 10. Fire and Smoke Dampers
    - a. Submit a schedule of selected dampers listing the following information for each damper: Location, nominal size, free area velocity, and pressure drop at free area velocity.
  - 11. Sound Traps
  - 12. VAV Boxes
  - 13. SMACNA "HVAC Duct Construction Standards - Metal and Flexible"

- B. **Shop Drawings:** Provide shop drawings of sheet metal ductwork and plenums as follows:
1. Draw to a scale not less than 1/8" to one foot, with sheet sizes equal to Contract Drawings.
  2. Show duct sizes, where possible use even duct sizes.
  3. Show fitting details.
  4. Show coordination with lighting fixtures, fire dampers, smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.
- C. **Shop Drawings:** Provide shop drawings for field erected mechanical equipment:
1. Draw to a scale of 1/2" to one foot, with sheet sizes equal to Contract Drawings.
  2. Show plan, sections, elevations and details of all joints and enclosures.
  3. Detail access doors and hardware.
  4. Detail coil, damper, humidifier, filter and fan installations.
  5. Show access space for electrical components that are part of the equipment provided and/or installed such as power and control panels on humidifiers. This shall be coordinated with Division 26 and NEC.
- D. **Certifications:** Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system furnished on the project include:
1. System name.
  2. Duct material.
  3. Duct gauge.
  4. SMACNA rectangular reinforcement number.
  5. SMACNA intermediate reinforcement number.
  6. SMACNA transverse reinforcement number.
  7. Rod diameter and type.
  8. Sealant type.
  9. Attachment method.
  10. Duct system design pressure.
- E. **Construction IAQ Management Plan:** Collaborate with the general contractor to submit and implement an IAQ Management Plan for the construction process meeting the requirements of the SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ Management Plan should address how compliance has been achieved in these required five areas as follows:
1. **HVAC Protection**
    - a. Shutdown of return side of existing HVAC system in areas effected by heavy construction.
    - b. Provision of temporary filters if existing or new systems must remain operational during construction.
    - c. Dampening of supply and returns and sealing of openings in areas subject to construction dust.
  2. **Source Control**
    - a. How will reduction of contaminants be reduced at the source?
    - b. What steps will be taken to employ low emitting products and sealants.
    - c. How will air handling equipment be cycled off when not needed.



3. Pathway Interruption
    - a. Describe how the construction space will be ventilated as required to dilute contaminants.
    - b. Describe how occupied spaces adjacent to construction areas will be kept at positive pressure relative to spaces under construction.
  4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
    - a. Reduction of dust generated by work will be suppressed.
    - b. Maintaining a frequent cleaning frequency for dust and particulates.
    - c. Remove spills or excess applications of solvent-containing products as soon as possible.
    - d. Remove accumulated water and keep work areas as dry as possible.
    - e. Protect insulation materials from exposure to moisture.
  5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.
- F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.
  - G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.
  - H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
  - I. At the discretion of the specifier, sheet metal gauges, and reinforcing may be checked at various times to verify all duct construction is in compliance.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.

### PART 2 - PRODUCTS

#### 2.1 DUCTWORK

- A. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Kaiser, Rolok or equal.
- B. Duct dimensions indicated on drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.
- C. Ducts shall be constructed of material gauges and reinforcement per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards. See also Part III Execution for matrix of materials and pressure requirements.

## 2.2 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - a Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].
  - b Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].
  - 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick.
  - 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Factory- or Shop-Applied Antimicrobial Coating:
  - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
  - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
  - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 5. Shop-Applied Coating Color: White.
  - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- H. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- I. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.3 DUCTWORK FABRICATION

- A. Joints – Sealing
  - 1. Duct tape is not allowed. Rolled elastomeric duct sealants are not allowed.
  - 2. Solvent-based and oil-based sealants are not allowed indoors.

3. Seal all transverse joints - this includes mechanical joints similar to Ductmate on all supply, return, exhaust and outside air intake ducts.
4. All sealant systems for outdoor application to be suitable for use in exposure to water. Vulcum 801 and 351.
5. All sealant systems for indoor application to be meet VOC limits as specified in South Coast Air Quality Management District Rule #1168 limiting VOC's to 100 g/l. Sealants by Hardcast, Ductmate, Mon-Eco Industries, United McGill or equal, as recommended for ductwork application.
6. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
  - a. Outdoor Application: Not permitted where subject to moisture exposure.
  - b. Indoor Application: Hardcast Iron Grip, Ductmate PROseal, Mon-Eco EZ Seal 44-44, or equal.
7. Two-Part Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal. Hardcast Two Part II, McGill Uni-Cast, or equal.

B. Joints - Rectangular Ducts

1. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure. Ductmate, MEX Industries, or equal are acceptable joint methods, but must be sealed as described previously. Transverse joints shall be constructed per Figure 1-4 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2" static pressures.

C. Joints - Round

1. Exposed Ductwork: Slip drive and sheet metal screws.
2. Concealed Ductwork: Sheet metal screws.

D. Elbows

1. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces, or as shown. Provide single thickness turning vanes on all short rectangular radius elbows less than 25" wide. Provide double thickness turning vanes for short rectangular radius elbows 25" wide and greater. Number of vanes per SMACNA. Elbows with square throat and radius heel are NOT allowed.

E. Transitions

1. Construct transitions with minimum slope of 1 to 5 ratio and in conformance to SMACNA.

F. Branch Connections

1. Provide 45° entry boots or radius taps for rectangular duct take-offs and conical or bellmouth taps for round duct take-offs. Straight 90° taps are not allowed, except where round take-off duct size equals round branch duct size. Provide volume dampers at take-offs for balancing if not specifically noted as provided at outlet or inlet. Provide insulation guards at transitions to lined ductwork.

## 2.4 RECTANGULAR DUCTWORK

- A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 1995 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted. All ductwork shall be stainless steel in, and around, magnetically/electrically sensitive rooms.

## 2.5 ROUND DUCTWORK

- A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. Spiral lock seams, only, to 50" diameter. Larger than 50" may be welded longitudinal or spiral lock seam. Lap or snap lock seams are not permitted for round ductwork of any size. Provide beaded sleeve joints or flanges with gasket joints. Elbows shall be 5-gore mitered and welded. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations. All connections shall utilize welded conical tees, aluminum conical fitting with damper by Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STOD. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Flat oval shall be utilized in space-restricted areas. All ductwork shall be aluminum in and around magnetically/electrically sensitive rooms.

## 2.6 FLEXIBLE DUCTWORK

- A. Flexible one-inch thick insulated round ductwork may be utilized where shown on the Drawings and at the last seven (7') feet to each air outlet and inlet, unless shown otherwise on the plans. Maximum of only one 90° bend in any length. No intermediate joints are allowed. Connect each end with stainless steel screw operated drawbands. Support duct to maintain smooth shape without sagging. All connections shall utilize welded conical tees, aluminum conical fitting with damper by Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STOD. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted.
- B. Flexible ductwork for low pressure systems with positive static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil, fiberglass insulation, and aluminized polyester, mechanically locked to galvanized steel helix without adhesives, exterior 1" fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 5B, Thermoflex Model MKE or approved equal.
- C. Flexible ductwork for medium and high pressure systems with static pressures above 2" w.g. through 10" w.g. positive pressure shall be a heavy coated fiberglass cloth fabric mechanically locked to galvanized steel helix without adhesives, exterior 1" fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 4B, Thermoflex Model MKC or approved equal.
- D. Flexible aluminum ductwork for use in magnetic/electrically sensitive room environments, such as MRI rooms, in low pressure systems with static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil with aluminum helix with exterior 1" aluminum jacket fiberglass insulation. Flexmaster #TL-B or approved equal.

## 2.7 ACOUSTICAL DUCT LINER

- A. Acoustic Duct Lining shall be installed where shown on the drawings and as specified for low velocity supply, return and exhaust ductwork. Liner is to be utilized to line vertical supply duct risers, mechanical shafts conveying return air, terminal box discharge plenums, and other horizontal duct runs where shown on drawings. Dimensions of lined ducts given on the drawings indicate the inside dimensions of duct after the lining has been installed. Black-coated (vinyl, acrylic or neoprene) duct lining shall be adhered by 100% covering of a fire retardant adhesive (3M EC-1128, Benjamin-Foster 85-20, or equal). When width of duct exceeds 12" and also on sides when height exceeds 24", use non-ferrous mechanical fasteners such as welded pins and speed clips, 12" on center maximum lateral spacing and 18" on center maximum longitudinal spacing. Start fastening within 3" of upstream transverse edge of the liner and within 3" of the longitudinal joint. Mechanical fasteners shall not pierce the duct walls. The pins shall be cut off flush, washers shall be used and installation made so that no gaps or loose edges occur in the insulation. Apply a brushcoat of Benjamin-Foster 30-36 to washers, extending onto lining surface a minimum of 2". Top pieces shall be supported by the side pieces. Provide insulated build out frames for attaching dampers at running vanes where required.
- B. All transverse and longitudinal abutting edges of duct lining shall be sealed and lapped 3" with a heavy coat of Foster 30-36, in accordance with the manufacturer's recommendations. All exposed edges shall be installed with sheet metal nosings. At all openings in the ductwork there shall be a galvanized metal flange, equal in depth to adjacent lining and having a 1½" lip to hold lining in place. All bolt holes shall be sealed airtight.
- C. Internal Duct lining shall be installed in complete accordance with the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) Duct Lining Application Standard. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1 from SMACNA. Adhesive shall be water-based and conform to Adhesive and Sealant Council Standards for Adhesives for Duct Liner ASC-A-7001C.
- D. Internal Duct Lining shall be 1" unless otherwise called out, matte-faced, 1.5 lb/ft<sup>3</sup> minimum density and shall meet the requirements of NFPA90-A.
- E. Acoustical duct liners shall comply with the following requirements and standards:
  - 1. ASTM C 1071, Type 1.
  - 2. NFPA 90A and 90B.
  - 3. Resist fungal growth.
  - 4. Support air velocities up to 5,000 fpm.
  - 5. Per UL 723 test method, flame spread shall not exceed 25, and smoke developed shall not exceed 50.
  - 6. Per test method ASTM C423 using Type A mounting, minimum allowable NRC shall be 0.45.
- F. The following are acceptable, subject to the above:
  - 1. Internal Duct Lining:
    - a. Aeroflex Type 150 from Owens-Corning Fiberglass, Toledo, OH.
    - b. Linacoustic/Spiracoustic Type 150 from Manville Products Corp., Denver, CO.
    - c. Ultralite Type 150 from Certain Teed Corp., Valley Forge, PA.
    - d. Pre-approved equal to above.
  - 2. Mechanical Fasteners:
    - a. Gemco TYPE IH-A from Goodloe E. Moore, Inc., Danville, IL.
    - b. Eckoustic-Klip from Eckel Industries, Inc., Cambridge or MA.
    - c. Pre-approved equal to above.

## 2.8 DUCT/VAV UNIT SOUND CONTROL LAGGING

- A. Where indicated on the drawings, VAV unit or duct shall be wrapped with minimum 2" thick glass or mineral fiber blanket, 1.5 lb/ft<sup>3</sup> minimum density and two layers of "mass-loaded" vinyl sheet. Each lead vinyl sheet shall weight 0.4-0.5 lb/ft<sup>2</sup> and shall be 0.025 - 0.040 inches thick. The lead vinyl shall be applied to the fiber base fabric with edges overlapped by at least 2 inches and sealed with duct tape. Complete system or lead/vinyl material shall provide a minimum STC-20 as measured in an independent accredited acoustical laboratory in accordance with ASTM E90 and/or E413.
- B. The following are acceptable:
  - 1. Gray Loaded Vinyl from Singer Partitions, Inc., Chicago, IL.
  - 2. Soundfab from The Soundcoat Company, Inc., Santa Ana, CA.
  - 3. EAR WB-5 from EAR Corporation, Indianapolis, IN or approved equal.

## 2.9 PLENUMS AND EQUIPMENT CASINGS

- A. Construct casings and plenums in conformance with SMACNA.
- B. Minimum Pressure Class: Unless otherwise indicated construct plenums and casings to withstand either a negative or positive static pressure of 4" W.G.
- C. Single-Wall: Provide single-wall, casings and plenums where indicated on the drawings.
  - 1. Construct in accordance with SMACNA Standards.
  - 2. Use steel-angle-reinforced standing-seam construction.
  - 3. Locate intermediate bracing angles bolted to the casing 24 inches on centers.
  - 4. Construct for static pressure indicated or for the maximum fan static pressure whichever is less.
  - 5. Bolt to 3" high concrete pads using 1½" x 1½" x ¼" thick galvanized steel structural sections.
- D. Double-Wall: Provide where indicated on the drawings, constructed as follows:
  - 1. Provide 4" thick prefabricated double wall insulated metal panel assemblies, with 16MS gauge aluminum or 18 gauge minimum galvanized steel outer sheets.
  - 2. Provide 22 gauge Type 304 stainless steel inner sheets.
  - 3. Casings shall be fully metal enclosed, insulated with 4" thick rigid fiberglass insulation and conforming to NFPA 90A, with maximum flame spread of 25 and maximum smoke developed of 50.
  - 4. Field or factory fabricate to size and configuration indicated on the drawings, using field verified dimensions.
  - 5. Provide coordinated shop drawings.
  - 6. Reinforce spans 10' or greater with structural steel sections to yield maximum deflection ¼" at minus 10" or plus 10" W.G. static pressure.
  - 7. Provide openings and doors, all factory framed, and reinforced with 304 stainless steel structural sections.
  - 8. Construct doors of same material as casings, of sizes and locations indicated on the drawings but not smaller than 18" by 54", and conforming to SMACNA.
  - 9. Provide doors, hinges and hardware factory fabricated and mounted.
  - 10. Door swings shall open against air pressure, with door latches operable from either side.
  - 11. Provide door seals with neoprene gaskets, which have an airtight seal.
  - 12. Provide each door with a 10" by 10" wire reinforced double pane window.
  - 13. Bolt base channel to 3" high concrete pads.

## 2.10 DUCTWORK SPECIALTIES

- A. General: Where specifically called for, materials for use in fabricating ductwork specialties shall be identical to that used to fabricate ductwork. See drawings and Part 3, Execution for schedule.
- B. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabrics Inc., Ventlok operating hardware. For accessible dampers, provide #641 self-locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3" W.G., provide #640 HiVel dial regulator and #609 HiVel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.
- C. Multi-louver Volume Dampers: 16 gauge galvanized steel frame. Opposed, 6" wide, 16 gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.
- D. Flexible Connections: Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation. Neoprene impregnated glass cloth with 24 gauge galvanized metal frame. Neoprene-only connectors are not allowed. Minimum dimensions - 3" metal, 3" fabric, 3" metal. Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.
- E. Ducts through roof shall be 16 gauge (or minimum of 2 gauges heavier than attaching ductwork), flashed and counterflashed, and provided with storm collars to secure a watertight construction.
- F. Bird Screens: 14 gauge, ½", galvanized wire mesh, set in a galvanized steel frame, screw set.

## 2.11 DUCT ACCESS PANELS AND DOORS

- A. In sheet metal work, hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 24" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or approved hinges and latches on all doors; 100 Series hinges and latches on low pressure system doors up to 18" maximum dimension, 200 Series on larger low pressure system doors and 333 Series on high pressure systems. Construct doors up to 18" maximum dimension with one inch overlap fit and gasket with ¾" by ⅛" sponge rubber, fit larger doors against 1½" by ⅛" flat stock or angle frame and gasket with ¾" by ⅛" sponge rubber or felt. Door swing to be opposite airflow. CESCO, Vent Products, Air Balance, Ductmate Sandwich or equal. Access doors smaller than 12" x 12" can be used for visual inspection of dampers, etc. on small ductwork less than 12" wide but must be of maximum size that will fit on duct with 6" x 6" as minimum size. All access doors smaller than 12" x 12" must be approved by Engineer for the specific application prior to ordering.

## 2.12 CONTROL DAMPERS

- A. General: Low leakage dampers are to have a maximum leakage rate of 3 cfm/ft<sup>2</sup> at 1.0 in w.g. pressure difference when tested to AMCA Standard 500.
- B. Damper Type One: Airfoil Low Leakage Dampers
  - 1. Application: Commercial supply, return, and general exhaust air systems up to 3,000 fpm velocity.
  - 2. Frames to be 5" x 1"x 16 gauge steel channel
  - 3. Blades to be 6" wide, 14 gauge galvanized steel design.
  - 4. Axles to be ½" diameter plated steel.
  - 5. Bearings to be stainless steel sleeve type pressed into frame.

6. Linkage to be concealed in frame
  7. Crank lever for operator to be provided.
  8. Provide with mill finish on blades and frame.
  9. Silicone rubber blade seals.
  10. Flexible metal jamb seals.
  11. Maximum temperature rating to be 300°F.
  12. Required Options:
    - a. Damper position indicator switch
  13. Manufacturer: Ruskin #CD60, Swartout, NCA PBD/OPD-AF-101, American Warming, Air Balance, Greenheck or approved equal.
- C. Damper Type Two: Airfoil low Leakage for coastal environments.
1. Application: Commercial supply, return, and general exhaust air systems where damper will be exposed to damp marine air and where velocity is less than 3,000 fpm.
  2. Frame to be 5" x 1" x 0.125 extruded aluminum
  3. Blades to be 6" wide, 6063-T-5 aluminum at approximately 6" centers, opposed blade design.
  4. Seals to be PVC coated polyester on blade edges, suitable for -25°F to +180°F. Jamb seal to be flexible metal compression type.
  5. Bearing to be molded synthetic.
  6. Linkage to be exposed on larger units and concealed on units under 14" high.
  7. Axles to be ½" plated steel hex.
  8. Control shaft to be ½" diameter. Outboard support bearing to be supplied with all single section dampers for field mounted operators. Factory installed jackshaft supplied on multiple section dampers.
  9. Unit to meet leakage rate of 5 cfm/sf at 3" W.G. when tested in accordance with AMCA Standard 500.
  10. Manufacturer: Ruskin #CD50, Swartout, NCA ACD-56-OB, American Warming, Air Balance, Greenheck or approved equal.
- D. Damper Type Three: Heavy Duty
1. Application: Velocity over 3,000 fpm and fan outlet damper.
  2. Frames to be 10" x 2" x 12 gauge steel channel.
  3. Blades to be 7¾" wide, 0.080 thick extruded aluminum airfoil design.
  4. Axles to be ¾" diameter plated steel.
  5. Bearings to be stainless steel sleeve type pressed into frame.
  6. Linkage to be out of airstream with 10 gauge galvanized steel clevis type arms on 7/8" diameter brass trunnions at 3" radius. Tie bar to be ¾" diameter plated steel.
  7. Crank lever for operator to be provided.
  8. Provide with mill finish on blades and frame.
  9. Maximum temperature rating to be 300°F.
  10. Options:
    - a. Silicone rubber blade seals.
    - b. Flexible stainless steel jamb seals.
    - c. Bearings with integral shaft seals.
    - d. Bearings bolted to frame.
    - e. Bolt holes in frame.
    - f. Special finishes.
    - g. Electric or pneumatic operator.
  11. Manufacturer: Ruskin #CD102, Swartout, American Warming, Air Balance, Greenheck or approved equal.



E. Damper Type Four: Airfoil Low Leakage Insulated Dampers

1. Application: Natural Ventilation inlets and outlets.
2. Frames to be steel or aluminum channel thermally broken with insulation within frame channels.
3. Blades to be 6" wide, Insulated ( $\frac{1}{2}$ " polystyrene), airfoil shaped, galvanized steel double skin construction of 14 gauge equivalent design.
4. Blade Seals: Extruded silicone rubber with flexible metal compression type jamb mating seal.
5. Axles to be  $\frac{1}{2}$ " diameter plated steel.(Optional stainless steel)
6. Bearings to be synthetic sleeve type pressed into frame.
7. Linkage to be concealed in frame.
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Maximum temperature rating to be 300°F.
11. Required Options:
  - a. Damper position indicator switch.
12. Manufacturer: Greenheck Model ICD-45, Ruskin #CD40x2, TAMCO Series 9000 BF, or approved equal performance insulating damper.

2.13 BACKDRAFT DAMPERS

A. Damper Types:

1. Heavy Duty Backdraft Dampers: Provide counterweight type complete with frame, end bearings, counterbalance assembly, blades, and linkage. Pressure drop to be no more than 0.24"w.g. at 1000 fpm. Install at outside air intakes, exhaust outlets, and where shown on Drawings. Pacific Air Products #PRD-100AL, Ruskin #CBD2, NCA, or equal by Swartout, American Warming or Vent Products.
2. Nonmetallic Backdraft Damper: Provide complete with 16ga frame, neoprene coated fiberglass blades, galvanized expanded metal grill. Ruskin NMS2.

B. Application Requirements:

1. Generator Discharge Damper: Heavy Duty Backdraft Damper. Size at no more than 1000 fpm velocity.
2. Outside Air Intakes except where a control damper is required – Heavy Duty Backdraft Damper.

2.14 LOUVERS

A. Louvers are generally to be provided under Division 10. Where louvers are not covered on architectural plans and specifications, contractor is to provide under the following specification:

1. Louvers to be 6" deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.
2. Frames to be constructed of 6" deep channel.
3. Provide with  $\frac{1}{2}$ " x  $\frac{1}{2}$ " galvanized mesh birdscreen mounted on backside of louver.
4. Finish/color per architect/engineer's review.
5. Manufacturer: American Warming, Industrial Louver, Vent Products, NCA, Swartout, Ruskin ELF6375DX Louvers & Dampers or equal.

2.15 DIFFUSERS, GRILLES AND REGISTERS

- A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer's representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution at NC 25 or less. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.
- B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper where individual duct mounted balancing dampers are not provided.
- C. Sizes, capacities and patterns shall be as shown on the Drawings. Manufacturer: Krueger, Titus, Price, Nailor, Anemostat, Carnes or Tuttle&Bailey.
- D. Provide the following devices identified with Titus model numbers:
  - 1. CSD-1 (Ceiling Supply Diffuser #1): Titus #MCD modular core ceiling diffuser with AG-40 opposed blade damper. Standard white finish. Mount on bottom of exposed ductwork.
  - 2. CLD-1 (Ceiling Linear Diffuser #1): Titus #ML-39 plenum slot diffuser, 1" slot, adjustable gasketed blade with internal liner, flat black finish, aluminum construction.
  - 3. FSD-1 (Floor Supply Diffuser #1): Krueger #FPDFR-R diffuser, 9¾" Diameter x 5¾" deep. Curved slot helical diffuser. High impact polymeric construction. With integral dirt receptacle also functions as a volume damper; Custom color per architectural drawings.
  - 4. WSR-1 (Wall Supply Register #1): Titus #272RL with adjustable front and rear blades, aluminum construction, with #AG-35 opposed blade damper, factory white finish, 1¼" blade opening.
  - 5. CRR-1 (Ceiling Return/Exhaust Register #1): Titus #PAR perforated face ceiling return, aluminum construction, flush demountable face, with type 3 border for lay-in tee bar application or type 1 border for surface mount applications. Provide 22" x 22" (or 12" x 12" per plan) registers and 22" x 22" (or 12" x 12" per plans) sheet metal plenum with reduced size outlet collar at lay-in tee bar ceilings. Outlet collar to match size indicated on plans. See architectural plans for ceiling types.
  - 6. CLR-1 (Ceiling Linear Return/Exhaust Register #1): Titus #MLR-39 return slot diffuser, 1" slot, adjustable gasketed blade with internal liner, flat black finish, aluminum construction.
  - 7. WRR-1 (Wall Return/Exhaust Register #1): Titus #3FL heavy duty return grille, aluminum construction, with ¾" blade spacing, 45° deflection, factory white finish, with #AG-35 opposed blade damper and blades parallel to long dimension.
  - 8. CTG-1 (Ceiling Transfer Grill #1): Titus #PAR perforated face ceiling return, aluminum construction, flush demountable face, with type 3 border for lay-in tee bar application or type 1 border for surface mount applications. Provide 22" x 22" (or 12" x 12" per plan) registers and 22" x 22" (or 12" x 12" per plan) sheet metal plenum with reduced size outlet collar at lay-in tee bar ceilings. Outlet collar to match size indicated on plans. See architectural plans for ceiling types.
  - 9. WTG-1 (Wall Transfer Grille #1): Titus #3FL return grille, aluminum construction with horizontal face bars, factory white finish, ¾" blade spacing, 45° deflection.
  - 10. Transfer Openings at Return Air Plenums: Contractor is responsible to provide transfer openings through full height walls between rooms at return air plenums. Openings are to be located above finished ceilings to allow free flow of return air back to inlets of ducted return air systems. Final sizes, locations and number of openings to be verified and coordinated with Architect or Engineer after walls are installed. Openings shall be finished with sheet metal caps.

2.16 DUCT SMOKE DETECTORS (DSD)

- A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Div. 26 area wide detection system. Coordinate with Div 16. work and electrical installer for power to smoke detector. Detector shall be mounted in the supply air ductwork downstream of the air handler and filters, or upstream of combination dampers. Coordinate with control installer to assure that detector shall shut down the air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct smoke detector shall be installed in compliance with the applicable mechanical or building code. Coordinate with Section 230900 and 230593 work. System Sensor #D2 series or approved equal.
- B. Additional requirements for duct smoke detectors include requirements per Section 6.4 of NFPA-90A. Provide one duct smoke detector at each story to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.

2.17 FIRE DAMPERS

- A. General:
  - 1. Provide UL labeled 3 hour rated fire dampers at 3-hour and greater penetrations.
  - 2. Provide UL labeled 1½ hour rated fire dampers at less than 3-hour penetrations.
  - 3. All dampers to be certified under the latest UL Standard. Certification based on former non-current standards is unacceptable.
  - 4. All damper installations to conform with NFPA 90A and manufacturer's installation instructions. Details on plans are shown for reference only.
  - 5. Install in ducts passing through floors, walls, and ceilings as required by code. Refer to Architectural and Mechanical plans for damper locations.
  - 6. Provide fire and fire/smoke dampers in locations as required by chapter 7 of the IBC.
  - 7. Provide sleeves, slip joints, retaining angles, duct access doors, ceiling access panels, etc., as required to check and service the fire dampers. Slip or break away joints are not allowed to be taped or sealed. Access doors shall be tight fitting hinged or sliding and shall have 1" high label reading "FIRE DAMPER" or "FIRE/SMOKE DAMPER".
  - 8. All dampers to be designed for use in dynamic systems.
  - 9. Dampers shall be rated for Leakage Class I. Leakage Class II may be used if damper size is smaller than available Leakage Class I dampers.
  - 10. Coordinate with "Security Bars" for installation in detention housing and high security areas.
  - 11. State Fire Marshall and local authority shall approve dampers for use.
  - 12. Dampers shall have an installed pressure drop of no more than 0.10"w.g. at the free area velocity. See submittal requirements above.
  - 13. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error. Do not install actuators in area where moisture can penetrate actuator or where temperature exceeds 120°F.
  - 14. Sizing: All fire dampers shall be sized to provide equivalent free area through the damper equal to the connecting ductwork. In no case are dampers' pressure drops to exceed those stated below. See also submittal requirements in Part One of this section.

- B. Radiation Ceiling Fire Dampers: Bladed ceiling fire damper constructed and tested in conformance with UL-555 (dynamic rating). Fire damper shall have a 165°F fusible link. Installation shall be in accordance with damper manufacturer's instructions. Provide fire blanket where required to obtain listed fire rating. Ruskin #CFD Series, Pottorff #CFD-15 Series or approved equal by CESCO, Air Balance, or Greenheck.
- C. Dynamic Fire Dampers: Curtain fire damper constructed and tested in conformance with UL-555C. Fire damper shall have a 165°F fusible link. Fire damper shall be equipped for vertical penetrations with manufacturer supplied sleeve. Installation shall be in accordance with damper manufacturer's instructions. Curtain damper shall not be located in air stream during system operation, Style B or C. Clear inside opening through fire damper is to match clear inside opening of duct. Fire dampers in lined ducts are to match size of sheet metal duct. Provide duct and ceiling access panel as required. Ruskin #DIBD Series, Pottorff #VFD-10 Series and #VFD-30 Series, or approved equal by Air Balance, Greenheck or CESCO.
- D. Combination Fire/Smoke Dampers:
  - 1. General Requirements:
    - a. Install at rated corridor wall or ceiling penetrations, occupancy separation walls, area separation walls and where shown on plans. Low leakage fire/smoke damper (Leakage Class 1 unless otherwise stated below) with electric actuator. Fire damper shall be equipped for vertical wall penetrations with manufacturer supplied sleeve and fail closed on loss of power. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Manufacturer shall provide factory assembled sleeve of 16" minimum length. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with IBC. All combination smoke and fire dampers shall automatically reset from closed to open position upon the reapplication of power to actuators.
    - b. Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.
      - 1. Actuator shall carry a manufacturer's 5-year warranty.
      - 2. Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
      - 3. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.
      - 4. Actuator shall have UL555S Listing by the damper manufacturer for 350°F and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23A at 120V running, or 0.1A holding at 120V (27 VA and 10 VA respectively for 24V power) for 70 in-lb torque.
      - 5. Stall and instantaneous type actuators are not acceptable.
      - 6. Do not install in area where moisture can penetrate damper or actuator nor where actuator temperature exceeds 120°F.
      - 7. All smoke and combination fire and smoke dampers shall be provided with Belimo Aircontrols FSNF120 (-S), FSNF24 (-S) actuators, or approved equal.

8. If a Honeywell ML-4115 actuator is submitted as an alternate, it must be provided with a time delay relay to cause the actuator to reset to drive open mode on momentary loss of power for less than 3 seconds.
2. Dampers for Low Velocity Applications (2000 fpm or below):
  - a. Fire damper shall have 6" wide galvanized steel blades with silicone rubber edge seals.
  - b. Pressure drop of a typical 24" x 24" size damper shall be no more than 0.05" w.g. at 1000 fpm velocity.
  - c. Basis of Selection: Ruskin #FSD-37, Ruskin #FSD-60, Ruskin #FSD60FA, Pottorff #FSD-140 Series, Pottorff #FSD-150 Series, or approved equal by Greenheck, CESCO or Air Balance.
3. Dampers for High Velocity Applications (2001 fpm or above):
  - a. Identical to above except, fire damper shall have 6" wide galvanized steel airfoil blades with silicone rubber edge seals.
  - b. Pressure drop at 2000 fpm velocity to be no more than 0.08" w.g. for a 24" x 24" size.
  - c. Basis of selection to be Ruskin FSD 60 with airfoil blade, Pottorff FSD-151, or approved equal air foil damper by Greenheck, CESCO or Air Balance.
4. Dampers for Ceiling Application:
  - a. Where indicated on plans install at rated corridor ceiling penetrations.
  - b. Integral smoke detection and actuating devices may be used if listed and approved for such service.
  - c. Basis of Selection: Ruskin #FSD36-C, Pottorff #FSD-172, CESCO CFSD-21, Greenheck CFSD, or approved equal by Air Balance.

## 2.18 AIR BLENDERS

- A. Prove air blenders of size as shown on Drawings, constructed of heavy gauge aluminum, all welded. Units shall be factory constructed and tested, and installed in accordance with manufacturer's recommendations. RM Products Co. or equal.

## 2.19 SOUND TRAPS

- A. Sound traps shall be I.A.C., Vibro-Acoustics, Aerosonics, United McGill, Transonics, Ruskin, or approved equivalent. Sound traps shall be sized for a maximum air pressure drop and maximum air velocity as noted on schedule.
- B. Materials
  1. Outer casings of rectangular silencers shall be made of 22 gauge type #G-90 lock-former-quality galvanized steel.
  2. Interior partitions for rectangular silencers shall be not less than 26 gauge type #G-90 galvanized lock-former-quality perforated steel.
  3. Filler material shall be as indicated on the Schedules and as appropriate for the application:
    - a. Standard fill: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof.

- b. Encapsulated fill for hospital or cleanroom applications: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof. Filler material shall be totally encapsulated and sealed with polymeric film of an appropriate thickness. The encapsulated fill material shall be separated from the interior perforated baffles by means of a noncombustible, erosion resistant, factory-installed, acoustic stand-off. It shall not be acceptable to omit the acoustic stand-off and try to compensate for its absence by means of corrugated baffles.
  - c. Packless sound traps: No sound absorptive material of any kind is to be used in the silencers. The silencers shall attenuate air/gas transmitted noise solely by virtue of controlled impedance membranes and broadly tuned resonators.
  - d. "Green" fill alternate: Acoustic fill material shall be 100% environmentally friendly, and constructed of recycled natural fibers. Each fiber shall be treated with an EPA registered fungal inhibitor in order to prevent mold, mildew, fungi, and pest protection. The fill material must not contain any harmful chemicals, irritants, and/or volatile organic compounds (VOCs) in order to prevent off-gassing.
4. Combustion ratings for the silencer acoustic fill shall be not greater than the following when tested to ASTM E 84, NFPA Standard 255, or UL No. 723:
- a. Flamespread Classification . . . . . 25
  - b. Smoke Development Rating . . . . . 50

C. Construction

- 1. Units shall be constructed in accordance with the ASHRAE Guide recommendations for high pressure duct work. Seams shall be lock formed and mastic filled. Rectangular casing seams shall be in the corners of the silencer shell to provide maximum unit strength and rigidity. Interior partitions shall be fabricated from single-piece, margin-perforated sheets and shall have die-formed entrance and exit shapes so as to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator. Blunt noses or squared off partitions will not be accepted.
- 2. Attachment of the interior partitions to the casing shall be by means of an interlocking track assembly. Tracks shall be solid galvanized steel and shall be welded to the outer casing. Attachment of the interior partitions to the tracks shall be such that a minimum of 4 thicknesses of metal exist at this location. The track assembly shall stiffen the exterior casing, provide a reinforced attachment detail for the interior partitions, and shall maintain a uniform airspace width along the length of the silencer for consistent aerodynamic and acoustic performance. Interior partitions shall be additionally secured to the outer casing with welded nose clips at both ends of the sound attenuator.
- 3. Sound attenuating units shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge from inside to outside the casing. Airtight construction shall be provided by use of a duct sealing compound on the jobsite material and labor furnished by the contractor.



D. Acoustic Performance

1. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM Specification E477-99. The test facility shall be NVLAP accredited for the ASTM E477-99 test standard. Data from a non-accredited laboratory will not be acceptable. The test set-up and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves, and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self-Noise (SN) Power Levels both for FORWARD FLOW (air and noise in same direction) and REVERSE FLOW (air and noise in opposite directions) with airflow of at least 2000 fpm entering face velocity. Data for rectangular and tubular type silencers shall be presented for tests conducted using silencers no smaller than the following cross-sections:
  - a. Rectangular, inch: 24x24, 24x30, or 24x36,  
and
  - b. Tubular, inch: 12, 24, 36, and 48

E. Aerodynamic Performance

1. Static pressure loss of silencers shall not exceed those listed in the silencer schedule as the airflow indicates. Airflow measurements shall be made in accordance with ASTM specification E477-99 and applicable portions of ASME, AMCA, and ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.

2.20 VARIABLE AIR VOLUME TERMINAL UNITS

- A. Furnish and install variable volume zone boxes of the sizes and capacities shown on the Drawings.
- B. The control assemblies shall be pressure independent and shall be able to be reset to any airflow between zero and maximum scheduled CFM. The valves shall be normally open. The differential static pressure of the basic assembly shall not exceed 0.25" W.G. for all sizes with inlet velocities of 2,000 FPM or less.
- C. The air valve shall be galvanized steel or die cast aluminum; damper shafts shall operate in rustproof Delrin or equal, self-lubricating bearings. The air valve shall seat against durable gaskets and not exceed a 2% leakage rate per ARI standards.
- D. The control device shall be designed to maintain constant flow regardless of inlet flow deflection. Duct inlets at 90° or less to the control device shall not alter the maximum or minimum factory setting by more than 10%. The assembly shall incorporate a multi-point averaging differential pressure sensor mounted on the inlet.
- E. The assemblies shall be contained in a welded 26 gauge galvanized steel box internally lined with ½ inch, 1½ lb. insulation complying with NFPA 90A and UL 181 standards.
- F. Acoustical lining is to be a scrim reinforced foil laminate using flexible 1½ lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All edges are to be sealed from the airstream, and metal brackets used to secure discharge edges on single duct terminals. For acute care facilities or surgery centers the inside surface of terminal units shall be galvanized sheet metal for a cleanable surface.
- G. Fabricate and install 5 foot (minimum) acoustically lined sheet metal discharge plenum on all air terminal units. Discharge plenum shall be mounted downstream of reheat coils where applicable. Inside dimension of plenum shall be 2" larger in height and 4" larger in width than the outlet of the air terminal unit or reheat coil, whichever is greater. Refer to detail on plans for additional information. This is required for acoustic noise dissipation.
- H. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed .35" w.g. for a double row coil or

0.20" w.g. for a single row coil. Coil shall be pressure tested to 200 PSIG. Coil section to be based on 180°EWT and 140°LWT unless otherwise noted on schedule. Maximum water pressure drop shall be limited to 5 feet w.g. unless otherwise noted.

- I. Electric Coil: Terminal manufacturer to factory install coil. Coil to be UL listed. They shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5" to prevent damage to elements during shipping. Elements shall be derated nickel chrome, supported by ceramic isolators a maximum of 3.5" apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety device. Provide a primary automatic reset thermal cutout, a manual reset secondary thermal cutout, line fusing, mercury contactors per element, differential pressure airflow switch for proof of flow, and line terminal block. Coil shall be capable of operating under continuous duty at 120°F discharge temperature. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Coils 4kw to 8kw shall be 2 stage, 8kw and larger shall be 3-stage. Coordinate final voltages with Div. 26.
- J. Controls to be direct digital. Provide boxes without operator. Provide factory mounted low voltage transformer of sufficient capacity to power the DDC controls. Coordinate control with temperature Control Contractor. Provide factory mounted operator and thermostat control if not provided by Control Contractor.
- K. Manufacturer: Titus ESV-3000, Price SDV, Trane VC, Enviro-Tec SSD, Carnes AV, Tuttle & Bailey SDV, Nailor 3000, or approved equal by Krueger or Anemostat.

### PART 3 - EXECUTION

#### 3.1 DUCTWORK MATERIAL APPLICATION SCHEDULE

- A. Fabricate ducts with galvanized sheet steel
  - 1. All duct system appurtenances are to be the same material as ductwork including volume dampers and access panels.

#### 3.2 DUCTWORK AND SPECIALTIES INSTALLATION

- A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.
  - 1. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.



2. Vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers. Provide additional fire dampers indicated on the Drawings and as otherwise required by the IBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.
  3. Provide 16 gauge metal sleeve with 1" clearance and pack space around ducts through walls tight with fiberglass, and seal with Schuller Duxseal or approved 3M fire proof caulking, as required. For exposed ducts through walls, provide flat, sheet metal escutcheon to conceal fiberglass and wall opening.
  4. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper only where individual duct mounted balancing dampers are specifically noted as not provided. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.
  5. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Vanes shall be single thickness type. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.
  6. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.
  7. Provide access panels or doors, as required, for access to valves, controllers, fire dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.
  8. Volume Dampers: Provide manual volume dampers in all low pressure supply, return and exhaust branch ductwork to grilles, diffusers, inlet and outlet openings to facilitate balancing of systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper operator.
  9. Splitters and splitter dampers shall not be installed in medium or low pressure supply ductwork to VAV systems.
- B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.
1. Maximum spacing between hangers shall not exceed eight (8) feet.
  2. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to IBC and architectural Drawings for seismic requirements.
  3. Do not support ductwork from fans or any other pieces of equipment.
  4. Powder driver fasteners shall not be used to support rectangular ducts of 40" maximum dimension. Powder driven fasteners shall not be allowed in existing facilities where electronic equipment is located.
  5. Support round duct, 30" and larger, with two hangers at each support point.

6. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.
7. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.

C. Other:

1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing oilers as required. Mount all fans on vibration isolators as specified.
2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When vapor barriers are specified, install continuous overall external surfaces of the entire system.
3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, supply ducts may be sized at a maximum velocity of 1,500 fpm or 0.08" sp friction per 100 feet, whichever provides the larger duct, and return/exhaust/intake ducts may be sized at a maximum velocity of 1,000 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct.
4. Humidifiers: Humidifier installation shall be approved by manufacturer and coordinated with all other systems. Condensate piping shall include p-traps as recommended by the humidifier manufacturer. Insulate exposed piping as required by the code.
5. Access Floor Diffusers: The mounting ring for floor mounted diffusers are to be affixed to the floor tiles using a clamp insert or other method approved for use with the floor diffuser.

3.3 CONSTRUCTION AND SEALING CRITERIA

- A. 233113 – Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

<u>Duct system:</u>	<u>Location</u>	<u>Working pressure</u>	<u>Build to SMACNA pressure class</u>	<u>Build to SMACNA seal class:</u>
Outdoor air intake	From ambient intake to AHU	-1" wc	-2" wc	B
Med press Supply Air	From AHU to air terminal units	+6" wc	+10" wc	A
Med press Supply Air	From AHU to air terminal units	+4" wc	+6" wc	A
Med press Supply Air	From AHU to air terminal units	+2" wc	+3" wc	B
Low press Supply Air	Downstream of air terminal units to grilles, registers or diffusers.	low pressure	+1" wc	B
Low press Supply Air	From AHU to grilles, registers or diffusers.	low pressure	+1" wc	B
Med. Press Return air	From air terminal units to AHU	-3" wc	-4" wc	A
Med. Press Return air	From air terminal units to AHU	-2" wc	-3" wc	B

<b><u>Duct system:</u></b>	<b><u>Location</u></b>	<b><u>Working pressure</u></b>	<b><u>Build to SMACNA pressure class</u></b>	<b><u>Build to SMACNA seal class:</u></b>
Med. Press Return air	From air terminal units to AHU	-1" wc	-2" wc	B
Low press Return air	From return grilles to AHU	Low pressure	-1" wc	B
Transfer air	From grille to grille, or acoustic boots or "z" bends	Low pressure	+0.5" wc	C
Relief air	From AHU to discharge at ambient	+1" wc	+2" wc	B
General exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
General exhaust	From exhaust fan to discharge at ambient	+1" wc	+2" wc	B
Washroom exhaust	From grille to exhaust fan	-1" wc	-2" wc	B
Washroom exhaust	From exhaust fan to discharge at ambient	+1" wc	+2" wc	B

- B. 233113 – The default leakage classification of ductwork is as follows:

<b><u>Duct working press. class:</u></b>	<b><u>Low pressure - +/- 0.5"wc</u></b>	<b><u>+/-1" – +/-3"</u></b>	<b><u>+/-4" – +/-10" wc</u></b>
SMACNA Seal Class	C	B	A
Sealing Applicable	Transverse joints only	Transverse and longitudinal Joints	Joints, seams, and all wall penetrations
Rectangular sheet metal SMACNA Leakage Class	24	12	6
Round sheet metal SMACNA Leakage Class	12	6	3

### 3.4 MANDATORY CALIFORNIA DUCTWORK TESTING

- A. All duct systems shall be sealed to a leakage rate not to exceed 6% of the fan flow if the duct systems are:
- Connected to a constant volume, single zone system, air conditioners, heat pumps or furnaces, and
  - Serve less than 5,000 square feet of floor area, and
  - Have more than 25% duct surface area located in one or more of the following places:
    - Outdoors, or
    - In a space directly under a floor where the U-factor of the roof is greater than the U-factor of the ceiling, or
    - In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
    - In an unconditioned crawlspace, or
    - In other unconditioned spaces.
  - The leakage rate shall be confirmed through field verification and diagnostic testing in accordance with procedures set forth in the Nonresidential ACM Manual.

3.5 FIBERGLASS DUCTWORK INSTALLATION

- A. Ductwork fabrication and installation to be inspected by a Qualified Fabricator certified by the material manufacturer. Oregon and Washington installations are to be inspected by E.J. Bartells Co.

3.6 COMBINATION FIRE, SMOKE DAMPER INSTALLATION

- A. Install per manufacturer's and UL installation requirements.
- B. Interlock operation of all fire smoke dampers to close dampers when the fans associated with the dampers are shut down. This also includes dampers in transfer ducts associated with system fans.

3.7 CONTROL DAMPER INSTALLATION

- A. Note that installation of control dampers is a part of the mechanical contractor's work regardless of whether they are specified in this section or as part of products to be selected by the Control Contractor.
- B. When electric actuators are provided, dampers shall be installed to allow direct over the shaft mounting of actuators. No connecting rods and stand off brackets shall be necessary.
- C. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error.
- D. Blades shall close completely. Leakage shall not exceed manufacturer's specifications at rated static.
- E. Structural support shall be provided as necessary for all multi-section dampers.
- F. Where blankoffs or structural supports obstruct duct or air passages, the decrease in free area shall not exceed 15% of the damper face area unless otherwise specified here or on plans.
- G. No individual damper section may exceed 20 sq. ft.

3.8 SEISMIC REQUIREMENTS

- A. See Section 230548 for specific requirements.
- B. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.
- C. The seismic calculations shall be the responsibility of contractor.

3.9 EQUIPMENT

- A. Install equipment as shown on plans and in accordance with manufacturer's installation recommendations.

3.10 SUPPLY DIFFUSER AND REGISTER LOCATIONS

- A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

### 3.11 PAINTING

- A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.

### 3.12 FIELD QUALITY CONTROL

- A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.
- B. Ductwork Deflection Criteria:
  - 1. Maximum inward and/or outward deflection at sheet-metal panels shall be  $\frac{3}{4}$ " under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed  $\frac{3}{4}$ ".
  - 2. Maximum inward and/or outward deflection at sheet-metal elbows and joints shall be  $\frac{1}{4}$ " under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed  $\frac{1}{4}$ ".
- C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 230593 "Testing, Adjusting and Balancing".

### 3.13 ADJUSTING AND CLEANING

- A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.
- B. Floor plenum cleanliness is vital to the success of under floor air distribution systems, and requires attention throughout the construction process. Contractor must thoroughly clean the air plenum area before the floor tiles are installed. Seal all floor openings in areas subject to construction dust and dirt getting into the floor plenum area. Refer to raised floor system manufacturer installation manual for more information.

END OF SECTION

## SECTION 23 31 14 - DUCT AND COIL CLEANING

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 RELATED WORK IN OTHER SECTIONS

- A. Section 230500: Basic Materials and Methods.

#### 1.3 SCOPE

- A. Clean the inside surface of all ductwork and plenums.
- B. Clean all evaporator and condenser coils.
- C. Clean all condensate pans.
- D. Clean all fan blades and assemblies.
- E. Clean all dampers, motors and linkages.

#### 1.4 MAINTAINING EXISTING SERVICES

- A. The existing heating, ventilating and air conditioning system shall be maintained to all occupied areas during the normal working week. Any exceptions to this rule must be arranged thru the Owner beforehand.

#### 1.5 PROPER EQUIPMENT

- A. The Contractor shall provide the power vacuum operating at a minimum of 16,000 C.F.M. at 21" W.C.; 25 CFM air compressor operating at 210 psi; electric power vent cleaner and reverse jet air flow nozzle, all staging, scaffold, ladders or similar equipment required to properly carry on the work. Suitable protective covering shall be provided by the Contractor in all areas of work operation. Any mechanical defects to be reported to all person/persons in charge.

#### 1.6 EXPERIENCED SUPERVISION

- A. All work shall be supervised by a Foreman having thorough knowledge and experienced in the cleaning of heating and air conditioning systems. The work shall be performed by experienced, qualified personnel. Contractor shall be responsible to coordinate with the Owner's Representative. This will insure that both parties are fully aware of work to be performed and time perimeters that work will be completed.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All materials specified by brand names used for the work described herein shall be delivered to the job site in original, un-opened, clean containers with labels in place. All such

materials shall be of the brand and type specified. Substitution of any materials will not be permitted, unless pre-qualified and approved by the Owner's Representative.

## 2.2 GASKETING

- A. Gasketing shall be a polyethylene foam, self adhering type with a minimum width of 1/4".

## 2.3 FIBERGLASS INSULATION MATERIAL

- A. Fiberglass insulation material to be repaired will be of equal quality and thickness as contained in equipment requiring repair. Fiberglass will be sealed together by means of wall tacks, lagging tape lagging adhesive and lagging coating. Materials used will be of the highest quality (ie: Foster White, Foster Coating: respectively).

## PART 3 - EXECUTION

### 3.1 STORAGE OF CONTRACTOR'S EQUIPMENT AND MATERIALS

- A. The contractor shall remove all materials from job site daily. Owner shall not be responsible for loss, theft or damage of any materials, equipment or devices provided by the Contractor while used on Owner's property.

### 3.2 CLEAN-UP

- A. Contractor shall, at the end of each shift, remove all waste, dirt and debris, resulting from the work performed. Such material shall be removed from the property and disposed of at the Contractor's expense, unless pre-qualified and approved by the Owner's Representative.

### 3.3 ACCESS OPENINGS AND DOORS

- A. Access will be cut into duct for proper cleaning. Sheet metal panels with proper caulking and of the same or heavier gauge metal shall be installed when the ducts are cleaned.

### 3.4 CAULKING

- A. Caulking shall be performed in a neat and effective manner. No caulking shall be applied over surfaces which contain dirt, rust, oil, scale, deteriorated caulking or other foreign matter which would affect adhesion. All caulking shall be Loctite Super Flex Caulking Compound or equivalent, as approved by the Owner's Representative.

### 3.5 COILS - (HEATING AND COOLING)

- A. Cleaning will consist of high power wash downstream of coil first and then upstream of coil. A detergent solution specifically designed for this purpose will be used in washing. Process will be repeated until coils have been rendered clean.
- B. High power wash will be performed with a water spray device that delivers a minimum of 500 P.S.I. Detergent cleaning shall be followed by a thorough rinsing with fresh water.
- C. A degreasing solution shall be used in areas required, (i.e. oil, grease, rubber or adhesive) build-up of the coils. Any degreasing of coils shall be performed before final cleaning of coils to insure complete removal of any residual build-up.
- D. Drain pans are to be cleaned and cleared before and after any pressure washing is performed, thus assuring complete and safe drainage.

3.6 PLENUM AREAS

- A. All interior walls, ceilings and floors shall be power vacuumed. Plenum areas shall be inspected and sealed air tight with approved caulking compound.
- B. Fiberglass insulating material found to be in need of repair will be repaired or replaced and properly bonded with adhesive, clips and proper lagging material.
- C. Fiberglass material shall be sealed with Quaker Koat after it has been thoroughly hand vacuumed to insure proper adhesion.

3.7 FANS AND FAN HOUSING

- A. Fan and fan assemblies shall be thoroughly cleaned by Power Vacuuming and high-pressure washing. Degreasing, scraping and wire brushing will be performed where required.

3.8 FILTERS

- A. New filters shall be installed when unit has been completely cleaned. Filters shall be provided by the Owner.

3.9 DAMPERS, MOTORS AND LINKAGE

- A. Dampers will be inspected and repaired.
- B. Repairs will include straightening and aligning of blades and linkage.
- C. All related equipment will be power vacuumed and high pressure washed where required.
- D. Areas with rust or scale build-up will be wire brushed or scraped.
- E. All damper motors and linkage will be lubricated and set into their original position upon completion of work in plenum areas.
- F. All ducts shall be thoroughly cleaned by power vacuuming. Ductwork that does not allow complete access shall be entered by means of access holes.
- G. All ducts will be cleaned, and inspected, as work proceeds. Any major repairs will be brought to the attention of the Owner's Representative.
- H. Minor repairs (ie: caulking, sealing, reconnecting) of ductwork will be performed in the normal manner of the contractor's work.

3.10 DAMAGE BY DIRT OR DUST

- A. The Contractor shall be responsible for all damage to any part of the Owner's premises, equipment or machinery due to dirt or dust attributed to the negligence of his work. The Contractor shall clean, repair or replace such damages at no expense to the Owner.

3.11 CLOSING IN OF UNINSPECTED WORK

- A. Contractor shall not allow or cause any of the work to be covered up or enclosed until it has been inspected and approved by an authorized person. Should any of his work be covered up or enclosed before such inspection, he shall, at his own expense, uncover the work, and after it has been inspected and approved, make all repairs with such materials as may be necessary to restore all his work to its original and proper conditions.

END OF SECTION



## SECTION 233413 – FANS AND VENTS

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
  - 1. Spun Aluminum and Steel Housed Centrifugal Exhaust Fans
    - a. General Duty Spun Aluminum Exhaust fan
    - b. Upblast Spun Aluminum Exhaust Fan for roof or sidewall mount
    - c. Upblast Spun Steel Exhaust Fan for high temperature kitchen exhaust

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230700: Mechanical Insulation
- D. Section 233113: Air Distribution
- E. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
- C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
  - 1. Air Movement and Control Association (AMCA):
    - a. 99 standards Handbook
    - b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
    - c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
    - d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
    - e. 500 Test Method for Louvers, Dampers, and Shutters
  - 2. American National Standards Institute (ANSI):
    - a. 9 Load Ratings and Fatigue Life for Ball Bearings
    - b. 11 Load Ratings and Fatigue Life for Roller Bearings
    - c. 900 Test Performance of Air Filter Units

3. Air-Conditioning and Refrigeration Institute (ARI):
  - a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
  - b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
  - c. 430 Central-Station Air-Handling Units
  - d. 440 Room Fan-Coil Air-Conditioners
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - a. 15 Safety Code for Mechanical Refrigeration
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
  - a. 70 National electrical Code
  - b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
  - c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4" per one foot. Include field fabricated mixing boxes, dampers and duct connections.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.
- B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.8 WARRANTY

- A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

1.9 SAFETY PROVISIONS

- A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens meeting OSHA requirements.

PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS

- A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association (AMCA). All fan wheels shall be statically and dynamically balanced. Size and capacity as indicated on the Drawings. Provide extended bearing lubrication fittings where necessary to assure accessibility of all lubrication points.
- B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40 degrees C above ambient temperature. Provide belt drive assembly capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts. All drives shall have adjustable sheaves to allow adjustment of  $\pm 20\%$ . Provide two speed, two winding motors where indicated on schedules.
- C. Accessories: Provide, as indicated on the Drawings and specified in other paragraphs of this Section, all related accessories to match the fan section, including access sections, diffusion sections, transition sections, flexible connections, vibration eliminators, and belt guards.
- D. Submissions: For shop drawings include complete dimensional and physical data, CFM, SP, HP, discharge arrangement, rotation, class, base details, and fan curves.

2.2 SPUN ALUMINUM AND STEEL HOUSED CENTRIFUGAL EXHAUST FANS

- A. Manufacturer: Models as scheduled manufactured by Greenheck, Carnes, Cook, Penn or approved equal.
- B. General Duty Spun Aluminum Exhaust Fan
  - 1. Direct Drive: Spun aluminum exhaust fans shall be direct drive type.
    - a. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a birdscreen.
    - b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors shall be readily accessible for maintenance. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment.
      - 1) Variable speed capability: For all direct drive fans with motors through  $\frac{3}{4}$ " hp, the fan shall be equipped with a DC electronic commutation type motor (ECM). Motor shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial

mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.

- c. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
  - d. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
2. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
- a. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a birdscreen.
  - b. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors and drives shall be readily accessible for maintenance.
  - c. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
  - d. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.
  - e. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
  - f. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

C. Upblast Spun Aluminum Exhaust Fan for Roof or Sidewall Mount

1. Direct Drive:
- a. Spun aluminum exhaust fans shall be upblast centrifugal direct drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure.
  - b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment free of discharge contaminants. Motors shall be readily accessible for maintenance. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

- 1) Variable speed capability: For all direct drive fans with motors through  $\frac{3}{4}$ " hp, the fan shall be equipped with a DC electronic commutation type motor (ECM). Motor shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.
  - c. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
  - d. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
  - e. Fan Arrangement:
    - 1) Roof Mounted Upblast Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fans shall be Model CUE as manufactured by Greenheck.
    - 2) Sidewall Mounted Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.
2. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
- a. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The windband shall be welded to the one-piece curb cap and on all sizes with UL/CUL-762.
  - b. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a tube sized for sufficient fresh air to provide motor cooling. Motors and drives shall be readily accessible for maintenance.
  - c. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
  - d. A NEMA 3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.
  - e. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
  - f. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

g. Fan Arrangement:

- 1) Roof Mounted Upblast Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength.
- 2) Sidewall Mounted Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.

h. Options:

- 1) Fans shall be Listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal
- 2) Grease Provisions:
  - a) Drain connection shall be constructed of aluminum and allow for a single point drainage of grease, water or other residues.
  - b) Grease Trap shall include the drain connection and shall be constructed from aluminum. The unit shall collect grease and water from the fan and extract the grease from the water for ease of grease disposal
- 3) Easy Clean Options: Hinge kit shall be constructed of heavy gauge aluminum hinges and shall include hold open cables for field installation. Non Stick wheel shall be constructed of aluminum with a non stick coating similar to Teflon® as manufactured by Dupont. Clean out port shall have a hole on the outside of the windband and a grease repellent compression rubber fit, allowing access to entire wheel for cleaning.
- 4) Curb Extensions: Shall be mounted between roof curb and roof mounted fans to meet NFPA requirements of 40 in. minimum discharge above the roof when mounted on a minimum 8 in. high roof curb.
- 5) Windband Extension shall be constructed from heavy gauge aluminum tube that raises the discharge an additional 36 inches.
- 6) Smoke Exhaust Option:
  - a) Provide dual belt drives be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
  - b) Fans shall be listed by Underwriters Laboratory for UL/cUL 705 for electrical components and UL/cUL Listed for Emergency Smoke Control Systems (500° F (260° C) for 4 hours and 1,000° F (538° C) for 15 minutes).

D. Upblast Spun Steel Exhaust Fan for High Temperature Kitchen Exhaust

1. General: Provide for charbroil and solid fuel burning exhaust applications
2. Spun steel exhaust fans shall be centrifugal belt driven type. Fan wheel shall be centrifugal backward inclined type. The wheel shall be constructed of steel and coated with a non stick coating similar to Teflon® as manufactured by Dupont. Wheel shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
3. The fan housing shall be constructed of 16 gauge galvanized steel with a rigid internal support structure and shall be leakproof. The fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength and shall be joined to the curbcap with a continuously welded seam.
4. Fan's windband shall have a Clean Out Port, a large diameter hole on the outside of the fan's windband with a grease repellent compression rubber fit, allowing access to entire wheel for cleaning.

5. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge galvanized steel. Motors and drives shall be mounted on heavy duty true vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a ten square inch tube free of discharge contaminants. Motors and drives shall be readily accessible for
6. maintenance. Precision ground and polished 1 inch minimum diameter fan shafts shall be mounted in cast pillow block lubricatable ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Dual drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts.
7. Motor pulleys shall be adjustable for final system balancing. All fans shall have a dual belt and pulley system.
8. A NEMA-3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed outside the motor compartment.
9. Certification and Identification:
  - a. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
  - b. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
  - c. Fans shall be Listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal. Grease Trap shall include the drain connection. The unit shall collect grease and water from the fan and extract the grease from the water for ease of grease disposal.
10. Hinge kit shall be constructed of heavy gauge hinges and shall include hold open cables for field installation.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Coordinate motor starters with Div. 26 and control contractor.
- B. Install in accordance with manufacturer's instructions.
- C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.
- D. Install unit on vibration isolators.
- E. Install 3" flexible duct connection at inlets and outlets of units.
- F. Control installers shall install all wiring associated with control signals into the fan starters.
- G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

#### 3.2 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 41 00 - AIR FILTRATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The requirements of Section 23 05 00 apply to all Work of Division 23.
- B. Provide all materials for the cleaning and filtering of the air supply as indicated on the Drawings and as specified.

1.2 QUALITY ASSURANCE

- A. All panel and extended surface air filters to be tested and rated in accordance with the ASHRAE Test Method Standard 52.1 and 52.2.
- B. All filter material to conform to Class I of California Code of Regulations (CCR) Title 19.80.03.
- C. Filters shall comply with State Fire Marshal Standard 51-6, and California Code of Regulations T-19.
- D. Comply with ARI 850

1.3 CONSTRUCTION SUBMITTALS

- A. Submit shop drawings and product data for filters and filter holding frames.
- B. LEED certification data as specified in Division 1, Section 01 81 13, "Sustainable Design Requirements", for the following LEED credits:
  - 1. Credit IEQ 3.1 & 3.2, Construction IAQ Management Plan

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Provide one complete set of filters for each filter bank. If system includes pre-filters, provide only pre-filters.
  - 2. Provide one container of red oil for inclined manometer filter gage.
- B. Provide temporary filters for all fans operated during construction; after all construction dirt has been removed from the building, install new filter at no additional cost to the District. In addition to temporary filters at filter location, provide temporary filters on all duct openings which will operate under a negative pressure.
  - 1. Filters used for temporary operation shall be the same as for permanent filters for the application. Filters used at duct openings may be 1-inch thick pleated media disposable type.
  - 2. Provide for a maximum of three changes of the return-air media filters during the phase of construction requiring permanent ventilation.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURER'S

#### A. Filters:

1. AAF International
2. Farr Co.
3. Viledon
4. Purafil, Inc.

### 2.2 AIR FILTERS

#### A. General:

1. Filters shall be 2-inch thick, medium efficiency pleated, disposable type, consisting of a nonwoven cotton and synthetic fabric media, with anti-microbial agent. The effective filter area shall be no less than 4 to 6 square foot media for each square foot of filter face area.
2. The media support shall be a welded wire grid, formed to affect a radial pleat design, with media bonded thereto.
3. The enclosing frame shall be heavy duty beverage board having diagonal support members bonded to both sides of pleats. Bond the inside periphery of the frame to the filter pack.
4. Filters shall be of the following distinct standard sizes:
  - a. 12x24x2
  - b. 16x20x2
  - c. 16x25x2
  - d. 20x20x2
  - e. 20x24x2
  - f. 20x25x2
  - g. 24x24x2
  - h. 25x25x2
  - i. 20x50x2
5. Filter media must be polyester, not fiberglass.

#### B. MERV 8 Filters:

1. The air filters shall be of the high efficiency, totally rigid and totally disposable type. Each filter shall consist of glass fiber media, support grid, stabilizers, diagonal support bracing and enclosing frame. Air filters shall have an average efficiency of 50 percent as determined by ASHRAE 52.2-2007 test method.
2. Filter media shall be of high density microfine glass fibers. The filter media shall have an average arrestance of not less than 95% on ASHRAE Standard (52.2-2007). Filters shall be listed by Underwriters Laboratories as Class 2.
3. The media support grid shall be a welded wire grid, with an effective open area of not less than 96% and shall be bonded to the filter media. The grid shall be designed to support the media both vertically and horizontally.
4. The contour stabilizers shall be galvanized steel and shall be permanently installed on both the air entering and air exiting sides of the filter media pack.
5. The enclosing frame shall be constructed of galvanized steel. The media pack shall be mechanically and chemically bonded to the inside of the enclosing frame. The enclosing frame shall be equipped with galvanized steel diagonal support braces. The diagonal braces shall be mechanically fastened to each contour stabilizer.
6. Packaging: After the filter passes all tests, it shall be cleaned and packaged in a plastic bag.
7. Filter media must be polyester, not fiberglass.

C. MERV 13 Filters

1. The air filters shall be of the high efficiency, totally rigid and totally disposable type. Each filter shall consist of glass fiber media, support grid, stabilizers, diagonal support bracing and enclosing frame. Air filters shall have an average efficiency of 85 percent as determined by ASHRAE 52.2-2007 test method.
2. Filter media shall be of high density microfine glass fibers. The filter media shall have an average arrestance of not less than 99% on ASHRAE Standard (52.2-2007). Filters shall be listed by Underwriters Laboratories as Class 2.
3. The media support grid shall be a welded wire grid, with an effective open area of not less than 96% and shall be bonded to the filter media. The grid shall be designed to support the media both vertically and horizontally.
4. The contour stabilizers shall be galvanized steel and shall be permanently installed on both the air entering and air exiting sides of the filter media pack.
5. The enclosing frame shall be constructed of galvanized steel. The media pack shall be mechanically and chemically bonded to the inside of the enclosing frame. The enclosing frame shall be equipped with galvanized steel diagonal support braces. The diagonal braces shall be mechanically fastened to each contour stabilizer.
6. Packaging: After the filter passes all tests, it shall be cleaned and packaged in a plastic bag.
7. Filter media must be polyester, not fiberglass.

2.3 UNIVERSAL HOLDING FRAME

- A. Holding frame shall be American Air Filter, Camfarr Type 8.
- B. Universal holding frames shall be constructed of not less than 16 gauge galvanized steel. They shall be equipped with polyurethane foam gaskets, fasteners and filter centering dimples. The four sealing flange corners shall be flush mitered and secured in order to form a uniform sealing and gasketing surface. The in-line depth shall be not less than 2.69" in order to effect adequate bearing surface for built-up filter banks. Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The universal holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener.
- C. The Design-Builder shall provide support systems, calculation and details prepared and stamped by a Structural Engineer who shall be registered in the State of California.

2.4 FILTER GAGES

- A. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0-3, 2.0 inch WG, 3 percent of full scale accuracy. DP ranges: 0-1.0" for pre-filters and 0-2.0" for final filters.
- B. Accessories: Static pressure tips with integral compression fittings, 1/4 inch aluminum tubing, 2-way or 3-way vent valves.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all air cleaning devices in accordance with approved shop drawings and the manufacturer's printed recommendations.
- B. Install differential magnahelic pressure gauges across each filter bank.
- C. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- D. Do not operate fan system until filters (temporary) are in place. Replace temporary filters used during construction.
- E. Install filter gage static pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.
- F. Provide alarm to indicate the time for change-out. Typical for all filter banks.
- G. Filter banks shall be installed without any measurable air leakages.

#### 3.2 TEMPORARY FILTERS

- A. Provide one set for each unit of fan belts and filters for construction, provide one set of filters for test and balance replace filters with one set of new filters prior to building handover.
- B. After completion of work and before final testing and balancing of the air handling systems, provide the specified permanent filters.
- C. Provide extra 1-year supply of filters for all air handling units and fan coil units.

END OF SECTION

## SECTION 23 74 13 - PACKAGED HVAC UNITS

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
  - 1. Packaged unit.
  - 2. Controls and control connections.
  - 3. Electrical power connections.
  - 4. Roof mounting frame and base.

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230700: Mechanical Insulation
- D. Section 230900: Controls and Instrumentation
- E. Section 233113: Air Distribution
- F. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
  - 1. Air Movement and Control Association (AMCA):
    - a. 99Standards Handbook
    - b. 210Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
    - c. 300Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
    - d. 301Methods for Calculating Fan Sound Ratings from Laboratory Test Data
    - e. 500Test Method for Louvers, Dampers, and Shutters
  - 2. American National Standards Institute (ANSI):
    - a. 9Load Ratings and Fatigue Life for Ball Bearings
    - b. 11Load Ratings and Fatigue Life for Roller Bearings
    - c. 900Test Performance of Air Filter Units

3. Air-Conditioning and Refrigeration Institute (ARI):
  - a. 210Unitary Air Conditioning Equipment
  - b. 270Sound Rating of Outdoor Unitary Equipment
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - a. 15Safety Code for Mechanical Refrigeration
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
  - a. 70National electrical Code
  - b. 90AStandard for the Installation of Air Conditioning and Ventilating Systems
  - c. 90BStandard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.

#### 1.5 PRODUCT SUBSTITUTIONS

- A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
  1. The proposed substitution does not affect dimensions shown on drawings.
  2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
  3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
  4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
- B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
- C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

#### 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for packaged units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.9 WARRANTY

- A. Provide general one year (12 months) warranty with five (5) year warranty on compressors under provisions of Division 01. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP HEATING/COOLING UNIT (GAS/ELECTRIC 3 TO 6 TONS)

A. General:

- 1. Outdoor rooftop mounted, electrically controlled heating and cooling unit utilizing a reciprocating compressor for cooling duty and gas combustion for heating duty. Unit shall discharge supply air downward or horizontally as shown on contract drawings.
- 2. Unit shall be rated in accordance with ARI Standards 210240 and 270. Designed in accordance with UL Standard 465.
- 3. Unit shall be designed to conform to ANSI/ASHRAE 15.
- 4. Unit shall be safety certified in accordance with U.L standard UL 1995 and ANSI Z21.47 Standards and CSA or CGA certified as a total package.
- 5. Roof curb shall be designed to conform to NRCA Standards.
- 6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Equipment (Standard):

1. General:

- a. Factory assembled, single piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-22) and special features required prior to field start-up.

2. Unit Cabinet:

- a. Unit cabinet shall be constructed of a minimum 18 gage G90 galvanized steel, bonderized and coated with an electrostatically applied powder coat finish on all externally exposed surfaces.
- b. Indoor blower compartment interior cabinet surfaces shall be insulated with a minimum 1/2" thick, flexible glass fiber insulation, coated on the air side. Aluminum foil faced glass fiber insulation shall be used in the furnace compartment.
- c. Cabinet panels shall have hinged access doors for servicing.
- d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
- e. Unit shall be provided with roof level lifting lugs.

- f. Unit shall have an external connection for field mounted condensate trap.
  - g. Unit shall have a stainless steel condensate drain pan.
- 3. Fans:
  - a. Indoor blower (evaporator fan):
    - 1) Fan shall be belt driven as shown on the equipment drawings. Belt drive shall include an adjustable pitch motor pulley.
    - 2) Fan wheel shall be airfoil blade plenum style.
    - 3) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
  - b. Indoor blower shall be made from aluminum and shall be dynamically balanced.
  - c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.
  - d. Outdoor fan shall have aluminum blades riveted to corrosion resistant steel spiders and dynamically balanced.
  - e. Induced draft blower shall be of the direct driven, single inlet, forward curved centrifugal type, made from steel with a corrosion resistant finish and dynamically balanced.
- 4. Compressor:
  - a. Fully hermetic type, internally protected.
  - b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
  - c. Equipped with a factory installed crankcase heater as required to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.
- 5. Coils:
  - a. Evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes with all joints brazed.
  - b. Tube sheet openings shall be belled to prevent tube wear.
  - c. Evaporator coil shall be of the interlaced design, degreased at the factory.
- 6. Heating Section:
  - a. Induced draft combustion type with energy saving direct spark ignition system and redundant main gas valve.
  - b. The heat exchanger shall be of the tubular section type constructed of a minimum of 16 gauge steel with a minimum 15 year non prorated warranty.
  - c. Burners shall be of the high-turndown type constructed of aluminum coated steel.
  - d. All gas piping shall enter the unit cabinet at a single location.
- 7. Refrigerant Components: Refrigerant circuit components shall include:
  - a. Thermostatic expansion valve.
  - b. Filter drier.
  - c. Service gauge connections on suction, discharge and liquid lines.
  - d. Refrigerant sight glasses
  - e. Compressor isolation valves
  - f. Manual reset high pressure and automatic reset low pressure switches

8. Filter Sections:
  - a. Standard filter section shall consist of factory installed low velocity, disposable 4" thick glass fiber filters of commercially available sizes.
  - b. Filter face velocity shall not exceed 320 fpm at nominal airflows.
  - c. Provide with factory installed Dwyer magnehelic gage
  - d. Provide with factory installed clogged filter switch
9. Controls and Safeties:
  - a. Unit Controls: Unit shall be complete with self contained low voltage control circuit protected by a manually resettable circuit breaker.
  - b. Safeties:
    - 1) Unit shall incorporate standard off the shelf components to perform the following functions:
      - I. Automatic reset low pressure switch
      - II. Manual reset high pressure switch
    - 2) Heating section shall be provided with the following minimum protections:
      - I. High temperature limit switch.
      - II. Induced draft motor air flow proving switch.
      - III. Flame rollout switch (manual reset).
      - IV. Flame proving controls.
10. Operating Characteristics:
  - a. Unit shall be capable of starting and running at 115° F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240.
  - b. Compressor with standard controls shall be capable of operation down to 62°F-65° F ambient outdoor temperature.
  - c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.
11. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory predrilled location.
12. Motors:
  - a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
  - b. Indoor blower motor shall have permanently lubricated bearings
  - c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.
  - d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.

C. Special Features and Options:

1. Provide the following options with units.
  - a. Roof Curb:
    - 1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.
  - b. Integrated Economizer:
    - 1) Integrated type capable of simultaneous economizer and compressor operation.
    - 2) Includes all hardware and controls to provide cooling with outside air.



- 3) Equipped with airfoil blade low leakage type damper.
- 4) Capable of introducing up to 100% outside air.
- 5) Equipped with a power exhaust fan with modulating relief damper.

c. Optional Compressor Cycle Delay:

- 1) Compressor shall be prevented from restarting for a minimum of 5 minutes after shutdown.

d. Factory Mounted DDC Controls

- 1) Mount and wire DDC controls components provided by Siemens Controls.
- 2) Incorporate DDC components into unit color coded wiring diagram
- 3) Bring all interconnecting wiring to a labeled terminal strip for field connection to indoor control panel and other field mounted components.
- 4) Use color coded wiring

D. Manufacturer: AAON Model RN & RQ Series, McQuay, or York.

## 2.2 SPRING ISOLATING ROOF CURB

- A. Curb mounted rooftop packaged air conditioning air handlers shall be flexibly ducted, provided with double arch EPDM Expansion Joints, and electrical lines with flexible conduits. The units shall be supported by a spring isolation curb, the lower member of which is a rigid steel tube or a specially formed steel section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must remain captive when resiliently resisting wind and seismic forces. All directional neoprene snubber bushings must be a minimum of 1/2" thick. Steel springs shall rest on 1/4" neoprene acoustical pads. Minimum spring deflection shall be 1 1/2". Hardware must be cadmium or zinc electroplated and the springs similarly plated or provided with an approved rust resistant finish.
- B. The curb's waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers.
- C. The floating member of the roof curb shall have perimeter angle and cross members to support two layers of 5/8" waterproof sheetrock laid on with staggered joints. Sheetrock must surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. Where the mechanical arrangement makes attachment to the floating member unfeasible, the barrier shall be attached at the highest practical elevation of the fixed curb with provision for 1" thick closed cell neoprene flexible seals around the ductwork. A four inch layer of 1.5 density fiberglass shall cover the entire solid roof surface under the unit. Ductwork shall be lined with sound absorbent material.
- D. Curbs shall be Mason Industries Type RSC-dB or approved equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that mounting surface, e.g. roof, is ready to receive work.
- B. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.

- C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.
- D. Mount rooftop unit on factory built roof mounting frame. Install roof mounting frame level.
- E. Install 3" flexible duct connection at inlets and outlets of units.
- F. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.
- G. Control installers shall install thermostat and all wiring associated with control signals into the units.
- H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
- I. Install a new set of filters prior to final air balance and substantial completion.

### 3.3 MANUFACTURER'S START-UP SERVICES

- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

## SECTION 23 81 45 - SPLIT HEAT PUMP UNITS

### PART 1 - GENERAL

#### 1.1 APPLICABLE REQUIREMENTS

- A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

#### 1.2 SCOPE

- A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
  - 1. Split heat pump unit
  - 2. Controls and control connections
  - 3. Electrical power connections

#### 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 230500: Basic Materials and Methods
- B. Section 230593: Testing, Adjusting and Balancing
- C. Section 230700: Mechanical Insulation
- D. Section 230900: Controls and Instrumentation
- E. Section 232300: Refrigerant Piping Systems
- F. Section 233113: Air Distribution
- G. Division 26: Electrical

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
  - 1. Air Movement and Control Association (AMCA):
    - a. 99Standards Handbook
    - b. 210Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
    - c. 300Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]

- d. 301Methods for Calculating Fan Sound Ratings from Laboratory Test Data
- e. 500Test Method for Louvers, Dampers, and Shutters
- 2. American National Standards Institute (ANSI):
  - a. 9Load Ratings and Fatigue Life for Ball Bearings
  - b. 11Load Ratings and Fatigue Life for Roller Bearings
  - c. 900Test Performance of Air Filter Units
- 3. Air-Conditioning and Refrigeration Institute (ARI):
  - a. 240Unitary Air-Source Heat Pump Equipment
  - b. 270Sound Rating of Outdoor Unitary Equipment
- 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - a. 15Safety Code for Mechanical Refrigeration
- 5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
- 6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
  - a. 70National electrical Code
  - b. 90AStandard for the Installation of Air Conditioning and Ventilating Systems
  - c. 90BStandard for the Installation of Warm Air Heating and Air Conditioning Systems
- 7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
- 8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.
- B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.8 WARRANTY

- A. Provide general one year (12 months) warranty with five (5) year warranty on compressors under provisions of Division 01. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM HEAT PUMP WITH INDOOR FAN COIL

- A. Acceptable Manufacturers: Carrier, Trane, York or approved equal.
- B. Indoor Fan Coil Unit
  - 1. General:
    - a. Factory fabricated fan coil units of the size, type configuration and capacity as scheduled on the drawings. Units shall be self-contained, factory assembled and pre-wired with condensate pump designed to operate with a two speed high efficiency heat pump.
    - b. All pressure drops, horsepower and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
    - c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
  - 2. Unit Casing
    - a. Unit shall be enameled, galvanized steel with minimum 1/2" 1.5 LB internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion. All exposed metal inside and out shall be finished with at least one coat of gray enamel.
  - 3. Fan Assembly
    - a. Direct-driven, double-width fan wheels shall have forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel.
    - b. Rotating assembly shall provide a rigid support for motor and fan assembly. Assembly shall be accessible and entire assembly shall be removable for maintenance.
    - c. Motor shall be 3 speed permanent split capacitor type with sleeve type bearings and oversized oil reservoirs.
  - 4. Coils
    - a. Coils shall be ARI certified and of the same manufacturer as the unit to insure proper fit and quality. All coil casings shall be galvanized steel minimum or stainless steel. Copper tubes shall be a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond. No exposed copper shall show between fins.
    - b. Coils shall be galvanized steel coated with closed cell fire retardant foam insulation.

5. Filter Section
    - a. Filters shall be on inch thick pleated filter. Filter velocity shall be less than 500 FPM.
  6. Unit Suspension
    - a. For horizontally suspended units manufacturer to provide factory welded mounting clips for suspension of units. Clips to be capable of accepting 1/2" rod or isolators. Weights shown on plans are maximum allowable operating weights including water in coils.
  7. Resistance Backup: Provide units with electric resistance backup heating capability. Coils to be of helix wound elements with limit controls and automatic reset.
  8. Provide return air cabinet as specified on Drawings. Cabinet shall be constructed of heavy gage steel with baked enamel finish.
    - a. Dampers: Outside air damper shall fail to closed position on shutdown.
    - b. Damper Gaskets: Provide tight fitting dampers with edge gaskets.
    - c. Damper Operator: 24 volt operation.
    - d. Mixed Air Controls: Provide economizer controls for all units over 2000 cfm or 49,000 btu nominal capacity. Maintain selected supply air temperature and return dampers to minimum position when ambient air temperature exceeds return air temperature.
  9. Thermostats
    - a. Electronic thermostat with subbase. Seven-day programming with minimum of 2 occupied/unoccupied periods per day. Individual temperature setpoints for heat and cool. Automatic heat/cool changeover. Intelligent recovery to automatically optimize start time depending on building load and setpoints. Locking setpoints and schedules to eliminate tampering. Subbase shall have a fan operation switch (On/Auto) and a conditioning switch (Auto/Cool/Off/Heat). Honeywell #T7300 thermostat and subbase series designed for use with heat pump, or approved equal.
- C. Outdoor Condensing Unit:
1. General: Provide remote outdoor heat pump compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve.
  2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.
  3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Motor to provide multispeed operation and enhanced low-speed efficiency and reduced noise. Fan blades to be statically and dynamically balanced. Condenser fan openings to be equipped with PVC-coated steel wire safety guards.
  4. Coil: Aluminum fins mechanically bonded to copper tubes.
  5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, R-410a refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.
  6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit.
  7. Controls: Provide. Provide an electronic anti-short cycle control., a malfunction output signal to the indoor thermostat and an outdoor thermostat for auxiliary heat staging. Provide a compressor quick start kit. Provide auto-reset high and low-pressure switches to continuously monitor system operation and mechanical and electrical interlocks between the low and high-speed contactors to eliminate the potential of compressor motor burnout due to contactor malfunction

- D. Efficiency: SEER of combined fan-coil and outdoor unit to be a minimum of 18 with an HSPF of 8.8.
- 2.2 SPLIT SYSTEM HEAT PUMP WITH WALL OR CEILING HUNG DUCTLESS INDOOR UNIT
- A. Acceptable Manufacturers: Carrier, Mitsubishi, Sanyo or approved equal.
  - B. Indoor Fan Coil Unit
    - 1. General:
      - a. Factory fabricated wall or ceiling mounted fan coil units designed for ductless application of the size, type configuration and capacity as scheduled on the drawings. Units shall be self-contained, factory assembled and pre-wired.
      - b. All pressure drops, horsepower and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
      - c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
    - 2. Unit Casing
      - a. High Wall Unit: Cabinet shall be fully insulated with polystyrene inlet and discharge grilles.
      - b. Ceiling Suspended Unit: Cabinet shall be zinc-coated bonderized steel finished with baked enamel paint. Inlet grilles shall be high-impact polystyrene.
    - 3. Fan Assembly
      - a. High Wall Unit: Tangential direct-drive blower with intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be standard.
      - b. Fan shall be centrifugal blower with air intake in the bottom rear of the unit and discharge in the front.
    - 4. Motors:
      - a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motor to be 3-speed.
    - 5. Coils
      - a. Coils shall be copper tube with ARI certified and of the same manufacturer as the unit to insure proper fit and quality mechanical bond. No exposed copper shall show between fins.
      - b. Coils drip pan shall be galvanized steel coated with closed cell fire retardant foam insulation. A secondary drip pan shall be included under the coil header.
    - 6. Filter Section
      - a. Filters shall be factory supplied cleanable filter.
    - 7. Controls: Microprocessor based with the following functions.
      - a. Automatic restart after power failure.
      - b. Internal temperature sensing controls shall sense return air temperature.
      - c. Indoor coil freeze protection.
      - d. Dehumidification mode shall be provided to increase latent removal capability by modulating fan speed and set point temperature.
      - e. Fan only operation shall be provided to permit room circulation when no cooling is required.

- f. Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during operating periods.
    - g. Compressor time delay to limit cycling.
  - 8. Special features:
    - a. Provide an internal condensate pump with interlock to unit operation in the event of malfunction.
    - b. Provide external electronic programmable thermostat for ceiling mounted units.
- C. Outdoor Condensing Unit:
  - 1. General: Provide remote outdoor heat pump compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve..
  - 2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.
  - 3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Condenser fan openings to be equipped with PVC-coated steel wire safety guards.
  - 4. Coil: Aluminum fins mechanically bonded to copper tubes.
  - 5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, R-410a refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.
  - 6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit.
  - 7. Controls: Provide an electronic anti-short cycle control, a malfunction output signal to the indoor thermostat and an outdoor thermostat for auxiliary heat staging. Provide a compressor quick start kit. Provide auto-reset high and low-pressure switches to continuously monitor system operation and mechanical and electrical interlocks between the low and high-speed contactors to eliminate the potential of compressor motor burnout due to contactor malfunction high condensing temperature protection. Systems diagnostics with matching fan coil.
- D. Efficiency: SEER of combined fan-coil and outdoor unit to be a minimum of 15 with an HSPF of 6.8.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that mounting surfaces are ready to receive work.
- B. Verify that proper power supply is available.

#### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide layout drawings of units, locations and power requirements to electrical installer.
- C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.



- D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
  - E. Provide 4" high concrete pad extending 6" beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.
  - F. Install 2" flexible duct connection at inlets and outlets of ducted units..
  - G. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.
  - H. Install copper refrigerant piping and insulate lines.
  - I. Install thermostat and all wiring associated with control signals between air handling unit and condensing unit. Conceal low voltage wiring in building structure, or inside the refrigerant pipe insulation, or in conduit.
  - J. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
  - K. Install a new set of filters prior to final air balance and substantial completion.
- 3.3 MANUFACTURER'S START-UP SERVICES
- A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

# **DIVISION 26**

## **ELECTRICAL**

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section supplements all Sections of this Division and shall apply to all phases of Work specified, indicated in the Contract Documents, and as required to provide for a complete installation of electrical systems for the Project.
  - 1. Provide control equipment for electrically operated equipment except when equipment is furnished with control equipment.
  - 2. Provide electrical work required for the service and connection of electrically operated and controlled equipment specified in other Divisions of the Specifications.
  - 3. Electrical power, signal, alarm and communication systems shall be complete, tested and ready for use.
- B. Provide operation and maintenance manuals for all systems as required for use of the District Staff in operating and maintaining the facility.
- C. Refer to other Divisions for additional requirements.

1.2 QUALITY ASSURANCE

- A. General Requirements: Work performed under this Division shall be installed by craftsmen skilled in the trade involved, and apprentices as indicated in General Conditions.
- B. Requirements of Regulatory Agencies:
  - 1. Codes and Ordinances: All Work shall meet the requirements of the codes as listed in Division 01.
  - 2. Materials shall bear the Underwriters Laboratories, Inc. (UL) label.
- C. Factory Tests:
  - 1. See each Section for the required factory tests and their procedures.
  - 2. Test reports shall include:
    - a. Description of equipment tested.
    - b. Description of tests.
    - c. Test results.
- D. Electrical Acceptance Tests:
  - 1. General Scope:
    - a. As part of the Contract, the services of a recognized testing laboratory shall be provided for the purpose of performing inspections and tests of installed Work as herein specified and specified in other Sections of Division 26 of these Specifications.
    - b. The testing laboratory shall provide all materials, equipment, labor and technical supervision to perform such tests and inspections.
    - c. All tests shall be performed in compliance with the recommendations and requirements of the National Electrical Testing Association, Inc., (NETA), and applicable codes and standards.
    - d. The Contractor shall submit test schedule and detailed test agenda for approval prior to testing.
    - e. Upon completion of the tests and inspections noted in these Specifications, a label shall be attached to all serviced devices. These labels shall indicate date serviced and the service company responsible.

- f. The tests and inspections shall determine suitability for continued reliable operation.
    - g. All tests shall be conducted in the presence of the Owner.
  - 2. Qualifications of Testing Agency:
    - a. The testing laboratory shall meet the Federal Occupational Safety and Health Administration (OSHA) criteria for accreditation of testing laboratories, Title 29, Part 1907. The Testing Agency and all personnel employed to perform testing shall have a minimum of 5 years experience in similar work.
    - b. Proof of the above qualifications shall be submitted in writing.
    - c. All instruments used to evaluate electrical performance shall meet NETA's Specifications for Test Instruments.
  - 3. Test reports shall include:
    - a. Description of equipment tested.
    - b. Description of test.
    - c. Test results.
    - d. Conclusions and recommendations.
    - e. Appendix, including appropriate test forms.
    - f. List of test equipment used and calibration date.
- E. All major equipment including but not limited to the following items shall be inspected for compliance with the reviewed shop drawings and requirements of the contract documents. The Contractor shall notify the Owner upon arrival of the equipment to the job site and provide all assistance for such inspection prior to the equipment installation.
  - 1. Switchgear, switchboards, panelboards, transformers.
  - 2. Lighting fixtures, including controls.
  - 3. Grounding.
  - 4. Conductors and cables.

### 1.3 SUBMITTALS

- A. Shop Drawings and Product Data and Samples:
  - 1. Submittals shall conform to Division 01 of the Specifications.
  - 2. Submit to the Owner six certified copies of the following:
    - a. A System Short Circuit Study based on 750 MVA fault at Medium Voltage Switchgear. Refer to 1.4 below.
    - b. A Coordination Study of all protective devices, including the utility protective device through all feeder devices on the secondary of each transformer down to breakers in panelboards and individual breakers in distribution boards. Refer to 1.4 below.
    - c. Manufacturer's printed instructions for operation and maintenance of electrical equipment, including replacement parts lists. Each set to be bound in an indexed loose leaf ring binder with permanent cover and permanent identification on edge.
    - d. Service and Operating Manuals for all equipment.
    - e. Three-phase voltage test.
    - f. Report showing test voltage L-N on the secondaries of all transformers.
    - g. Grounding systems tests.
    - h. Test reports.
    - i. Factory tests.
  - 3. Samples will not be returned, unless otherwise noted.
- B. Qualifications of Electrical Testing Laboratory.
- C. Documentation showing training of Owner.

1.4 SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

A. General:

1. Provide six copies in hard cover 3-ring binders, each including complete short circuit and protective device coordination studies.
2. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
3. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
4. Include on the curve sheets power company relay and fuse characteristics, system medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
5. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
6. Short circuit and protective device studies must be prepared with a digital computer. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on Drawing one-lines.
7. Provide short circuit and protective device coordination studies carried out by a professional electrical engineer registered in the State of California. Provide studies prepared by persons experienced in the work. Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. See item Paragraph 1.4 C. for qualifications. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit a draft of the study to the

- Owner for review. Make all additions or changes as required by the reviewer. Equipment shop drawings will not be reviewed until short circuit and protective device coordination study shop drawings have been submitted.
8. Series rating shall not be acceptable.
  9. Utilize equipment load data for the study obtained by the Contractor from Contract Documents, including Contract Addenda issued prior to bid opening.
  10. Include fault contribution of all existing motors in the study. Obtain all required existing equipment data. Notify the Owner in writing of existing circuit protective devices not properly rated for new fault conditions.
  11. Provide settings for the chiller motor starters obtained from the manufacturer and include in the study package, and comment.
  12. Evaluate proper operation of the ground relays in 4 wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
  13. For motor control circuits, show the MCC full load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.
- B. Implementation of Short Circuit and Protective Device Coordination Studies Results: The drawings and specifications indicate the general requirements for the electrical equipment being provided. Upgrade and modification to equipment characteristics and ratings will be finalized by the results of the short circuit and protective device coordination studies. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted short circuit and protective device coordination studies, shall be carried out by the Contractor at no additional cost to the District.
- C. Qualifications for Power System Analysis:
1. Power system study to be performed by an independent, third party firm not involved in supply of the equipment nor involved in final field testing and settings of this project.
  2. The study shall be performed, stamped and signed by a registered professional engineer in the State of California. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Owner for approval prior to start of the work. A minimum of 15 years experience in power system analysis is required for the individual in charge of the project.
  3. The firm performing the study should demonstrate capability and experience to provide assistance during start up if required or if called for. The individual in charge of the study work should have proven field experience. The individual in charge should be aware of most recent ANSI/IEEE changes and familiar with standards C37.010, C37.16, IEEE-242, IEEE-446, IEEE-399 and IEEE-141.
  4. For computer software, use the SKM Systems 'Dapper' latest version and 'Captor' latest version programs. In addition to the software generated printouts, produce a short circuit device evaluation table including the bus number, bus name, phase and ground fault currents, X/R ratio, 110% of the calculated fault current, bus bracing, and AIC rating of the devices on the bus.

## 1.5 LOCATION AND ROUTING

- A. The Drawings indicate diagrammatically the desired location or arrangement of conduit runs, outlets, equipment, etc., and are to be followed as closely as possible. Judgment must be exercised in executing the Work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions. The Contract Documents are not intended to show every detail part, support, final connection, accessory, or every structural difficulty that may be encountered during the Work. Except as otherwise indicated, locations of items are approximate

only. Exact locations necessary to secure proper conditions and results shall be determined at Project Site and shall be approved by the Owner.

- B. Locations shown on Architectural Ceiling Drawings or on wall elevations shall take precedence over electrical plan locations.
- C. Verify dimensions and the correct location of equipment and coordinate with other trades for any requirement before proceeding with the roughing-in of connection.
- D. Lighting fixtures in mechanical spaces and elevator machine rooms are shown in their approximate locations only. Do not install light outlets or fixtures until mechanical piping and ductwork are installed; then lighting fixtures shall be installed in locations best suited for equipment arrangement and as approved by the Owner. Verify locations of fixtures in elevator machine rooms before installation.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any Work, carefully check and verify all dimensions, sizes, etc., with the Drawings to see that the equipment being installed will fit into the spaces provided.
- F. Locations of Openings: Locate all chases, shafts and openings required for the installation of the electrical Work during framing of the structure. Do any cutting and patching required due to improperly located or omitted openings with the approval of the general contractor, who must also approve any additional changes resulting from relocation or omission of openings.
- G. G. Access to Equipment: Locate starters, switches, receptacles, cable tray and pullboxes to provide easy access for operation, repair, and maintenance, and if concealed, provide access doors.
- H. The Contractor shall be responsible for verifying that equipment being provided by him will fit dimensionally in locations shown on Drawings.

#### 1.6 MATERIALS STANDARDS

- A. Materials and equipment shall be new.
- B. All Work shall meet the requirements of the governing codes as listed in Division 01, and the requirements of the following:
  - 1. National Electrical Manufacturer's Association (NEMA).
  - 2. American National Standards Institute (ANSI).
  - 3. Institute of Electrical and Electronic Engineers (IEEE).
  - 4. Institute of Cable Engineers Association (ICEA).
  - 5. National Electrical Contractors' Association Standards for Construction (NECA).
  - 6. Underwriters Laboratories, Inc. (UL).
  - 7. Americans with Disabilities Act (ADA).
  - 8. California State and Local Fire Marshal.
  - 9. Instrument Society of America (ISA).
  - 10. California Electrical Code (T-24, Part 3), 2007 edition, (CEC).
  - 11. California Fire code (T-24, part 9), 2007 edition, (CFC).
  - 12. California energy code (T-24, part 6).
  - 13. National Fire Protection Association (NFPA): Pamphlet 101, Life Safety.
  - 14. State Industrial Accident Commission.
  - 15. California Building Code, latest edition (CBC).
  - 16. Occupational Safety and Health Administration (OSHA).
  - 17. DSA Fire Marshall Requirements.

- C. Items for similar application shall be of the same manufacturer.
- D. The label of listing by UL shall appear on all materials and equipment for which standards have been established by the agency.
- E. Where codes are listed in Division 01 that established label or approved requirements, furnish all materials and equipment with either the required labels affixed or the necessary written approval.
- F. Provide the type and quantity of electrical materials and equipment necessary to complete Work and all systems in operation, tested and ready for use.
- G. Provide all incidental items that belong to the Work described and which are required for complete systems.

#### 1.7 ACCEPTANCE TESTING OF THE ELECTRICAL DISTRIBUTION SYSTEM

- A. Upon completion of the Work and adjustment of all equipment, conduct an operating test for each system approval. Demonstrate all systems and equipment to operate in accordance with all requirements of the Contract Documents and to be free from all electrical and mechanical defects. Provide all systems free from short circuits and grounds and show an insulation resistance between phase conductors and ground not less than 250,000 ohms. Test all circuits for neutral connection. The Owner shall be notified fourteen days in advance of when tests will be performed.
- B. Conduct resistance to ground tests to measure resistance to ground at all grounding electrodes. Make tests before slabs of affected areas are poured in order that corrective measures, if required, may be taken. If the resistances exceed values specified in Section 26 05 26, perform all corrective measures as approved by the Owner.
- C. Prior to energizing any motors, measure the service voltage for phase balance and report immediately to the Owner if unbalance exceeds 1% from mean.
- D. Measure the three-phase voltage at no load and at maximum load conditions.
- E. Complete all tests prior to final field observation of Project, including corrective Work based on the results of the tests.

#### 1.8 WARRANTY

- A. Provide at least two years (or higher as indicated elsewhere) warranty for all materials and labor for the entire electrical system.

#### 1.9 TRAINING

- A. Provide a period of 40 hours for the necessary training program and instructions to the selected Owner employees for the electrical system for the entire building in addition to what is specified in each section.

#### 1.10 JOB CONDITIONS

- A. Notify the Owner in writing of dimensional discrepancies and other conditions detrimental to proper performance of the Work.



1.11 DEFINITIONS

- A. Certain terms in these Specifications, or on Drawings, shall be defined as follows:
- B. "Provide" - Furnish and install complete and ready for service.
- C. "Utility Area": Electrical, Mechanical, Generator, Elevator Machine Rooms, Telecommunications Rooms, and Tunnel/Trench.
- D. "Exposed" - Exposed to view after construction is completed.

1.12 COMMISSIONING

- A. Commissioning of all systems shall be provided by the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All switchgear, switchboards, panelboards and circuit breakers shall be of the same manufacturer.
- B. All wiring devices such as switches, receptacles, etc. shall be of the same manufacturer.

PART 3 - EXECUTION

3.1 SEISMIC PROTECTION

- A. Seismic Protection Criteria: Electrical equipment or machinery installations in any Seismic Risk Zone of the California Building Code Seismic Risk Map shall be protected from earthquakes. Protection criteria for these zones shall be a Horizontal Force Factor as prescribed by the CBC multiplied by the equipment or machinery weight considered passing through the equipment or machinery center of gravity in any horizontal direction. Unless vibration isolation is required to protect equipment or machinery against unacceptable structure transmitted noise and/or vibration, equipment or machinery shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The force factor and anchorage shall be determined by calculations performed by a registered California Structural engineer whether the isolators are present or not and shall be verified by the seismic restraint vendor. Vibration isolated equipment or machinery shall be protected by protected spring isolators or separate seismic restraint vendor. Seismic snubbers and protected spring isolators shall be seismic protection rated in three principal axes by independent laboratory testing or analysis by an independent licensed structural engineer. The Contractor shall be responsible for the design of his own seismic restraint systems. He shall supply to the Owner details of the forces exerted by his restraints, anchorages, and other points of attachment. Seismic protection, labor, materials and design shall be included in the Contract Sum.
- B. Electrical equipment or machinery shall be installed in accordance with the following guidelines:
  - 1. SMACNA publication: Guidelines for Seismic Restraints of Mechanical Systems.
  - 2. California Building Code (CBC), Title 24.

- C. The Contractor shall provide structural calculation and shop drawings for electrical equipment or machinery support. These drawing and calculations shall be prepared, stamped and signed by a Registered California Structural Engineer, and submitted for review and approval.
- D. Construction of all electrical gear, and equipment such as switchgear, switchboard, motor control center, panelboard, transformer and similar equipment shall meet seismic zone 4 requirements.

### 3.2 SETTING OF PROTECTIVE DEVICE

- A. Prior to final completion of the Project, set all protective device relays and internal settings to provide adjustment between upstream and downstream protective devices. Settings shall be based on the accepted coordination study.

### 3.3 IDENTIFICATION

- A. The Contractor shall identify all piping, conduit, machinery, and equipment.

### 3.4 EXCAVATION AND BACKFILL

- A. General:
  - 1. Do all excavation and backfill required to install the work in this Division.
  - 2. All excavating, trenching and backfilling required for this Division shall be done in accordance with the applicable requirements in Division 02. All excavating and backfilling, repaving all cuts, and providing and maintaining all protective measures for the excavation shall be in accordance with Division 02.
- B. Excavation: Bury conduits outside the building to a depth of not less than 2'-6" below finished grade unless noted otherwise.
- C. Backfilling: Do not backfill until final inspection and approval for the conduit installation by the Owner. Backfill material shall be in accordance with Division 02.

### 3.5 CUTTING AND PATCHING

- A. Field verify all openings indicated on the Drawings. Provide all cutting and patching required for electrical work.
- B. Sleeves and inserts: Provide all sleeves, inserts, and openings necessary for the installation of the Electrical Work. Provide sleeves in all floors and concrete walls.
- C. Openings for all electrical equipment shall be field verified:
  - 1. Special forming, recesses, chases, and curbs, for the correct reception and installation of the electrical equipment, as shown on the Drawings, are specified in other divisions.
  - 2. Ascertain that provisions have been made for the Work. If such provisions are not made in time, the Contractor shall bear all extra costs incurred in later cutting and patching to accommodate the work.
- D. Penetrations:
  - 1. All penetrations through fire rated walls to be sealed with fire stopping. Refer to Section 07 84 00.

2. All penetrations through exterior walls and beneath slabs-on-grade shall be sealed with weatherproofing material.
3. All penetrations through acoustically treated walls shall be sealed with non-hardening resilient Acoustic sealant.

### 3.6 PROTECTION AND CLEANING

- A. Protection: Fully protect all finished parts of the materials and equipment against physical damage from whatever cause during the progress of the work and until completion.
- B. During construction, cap all conduits so as to prevent the entrance of sand and dirt.
- C. Cleaning: After installation has been completed, the Contractor shall clean all systems as follows:
  1. Equipment with Factory Finish: Clean exterior thoroughly to remove grease, oil, plaster, cement and dirt, and leave surfaces clean and polished.
  2. Equipment to be Painted: Clean exterior of piping and equipment exposed in completed structure, removing rust, plaster, cement and dirt by wire brushing. Remove grease, oil and similar materials by wiping with clean rags and solvents.

### 3.7 OPERATIONAL TESTS

- A. Before acceptance tests are performed, demonstrate to the Owner that all systems and components are complete and fully operational.
- B. Perform operational tests on all equipment to determine compliance with Specifications.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide grounding system as shown on the Drawings and as specified, complete.

1.2 QUALITY ASSURANCE

- A. Testing: The contractor shall pay for the services of a qualified testing laboratory to perform the specified tests. The contractor shall notify the owner 72 hours in advance of performance of work requiring testing.

1.3 SUBMITTALS

A. Tests and Reports:

1. Testing agency shall report results of tests to the Contractor who shall approve or disapprove results.
2. Conduct resistance-to-ground tests to measure resistance-to-ground at all grounding electrodes. Make tests before slabs of affected areas are poured in order that corrective measures, if required, may be taken. If the resistances exceed values specified, perform all corrective measures as approved by the Contractor.
3. The resistance to ground for all systems shall be measured by the "direct" method or "fall-of-potential" method.
  - a. Perform "fall-of-potential" test per Institute of Electrical and Electronic Engineers (IEEE) Standard No. 81, Section 9.04 on the main grounding electrode or system.
  - b. Perform the 2 point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
  - c. The earth electrode under test must be far enough away from the water pipe system to be outside its sphere of influence. Rule of thumb: Distance from the earth electrode system to the water pipe system should be about 10 times the radius of the electrode or grid to obtain a measurement within an accuracy of plus or minus 10%.

B. Records:

1. A certified record of ground-resistance test on each driven ground rod, ground rod assembly, and other grounding electrodes shall be prepared and submitted for approval to the City of Santa Monica upon completion of this part of the work.
2. The record shall include the number of rods driven and their depth at each location to meet the required resistance to ground measurements specified. A statement shall be included describing the condition of the soil at the time of measurement.

C. As-Built Drawings:

1. As-built drawings shall indicate the location of all ground rods and supplementary grounding electrodes connected to the grounding system.
2. The location of each ground rod, ground-rod assembly, and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground resistance tests.

#### 1.4 REFERENCES

- A. ANSI/NFPA 70 - California Electrical Code.
- B. IEEE Standard 80 – Guide for Safety in AC Substation Grounding.
- C. IEEE Standard 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Parts 1 & 2).
- D. IEEE Standard 141 – Recommended Practice for Electrical Power Distribution for Industrial Plants.
- E. IEEE Standard 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- F. UL 467 – Electrical Grounding and Bonding Equipment.
- G. UL 869 – Electrical Service Equipment.
- H. Materials and/or installation shall meet or exceed the above referenced standards.

#### 1.5 SYSTEM REQUIREMENTS

- A. Grounding shall be as approved by the State of California, Division of Industrial Safety.
- B. Electrical continuity to ground metal raceways and enclosures, isolated from the equipment ground by use of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of approved size within each raceway connected to the isolated metallic raceways or enclosures at each end.
- C. The main service ground bus shall be bonded to the 2" or larger metal cold water line with minimum of 1" conduit with 1 No. 4/0 wire. All metallic piping systems (gas, fire sprinkler, etc.) shall be bonded to the cold water line with 3/4" conduit with 1 No. 8 wire.
- D. Noncurrent-carrying metal parts of all high voltage, light and/or power and signal conduit systems, supports, cabinets, switchboards, enclosures, fixed equipment, portable equipment, and motor frames shall be permanently and effectively grounded.
- E. Service neutral conductor of light and/or power alternating current systems shall be grounded if the maximum voltage to ground does not exceed 150 volts. Higher voltage service neutrals shall be grounded as indicated on the Drawings.
- F. Secondary neutral conductor of all light, power and signal alternating current systems shall be grounded. Neutrals shall be grounded at supply side of first switch controlling the system. Where no switch controls the entire system, the neutral shall be grounded at the transformer.
- G. Provide a "made electrode" bonded to the equipment enclosure for each light and/or power system. Grounded (neutral) conductors shall be terminated at the neutral bus of the first panel or switchboard and the neutral bus, equipment enclosure, and "made electrode" shall be bonded together.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Yard boxes shall be precast concrete and shall be approximately 14" wide, 19" long and 12" deep (outside dimensions), or larger, if necessary to obtain the required clearances. Boxes shall be equipped with bolt down, checkered, cast iron covers and a cast iron frame cast into the box. Yard boxes shall be Brooks 36, Associated E17 Series, or equal.
- B. Made electrodes shall be approved copper clad steel ground rods, minimum of 3/4" in diameter. Rods shall be 10 feet in length.
- C. Grounding and bonding conductors shall be soft-drawn stranded copper conductors.
- D. Ground bars (ground buses) shall be copper with required insulators and stand-offs by Cadweld (Erico Products, Inc.) or equal.
- E. System grounding conductors shall be a minimum of #4/0 AWG unless otherwise indicated, and shall be continuous without joints or splices.
- F. Bonding conductors shall be in accordance with the CEC.
- G. All grounding system connections shall be exothermically welded or irreversible compression ground connectors. All welding materials used shall be "Cadweld" materials, as manufactured by Erico Products, Inc., Burndy, or equal.
  - 1. Connections made outdoors shall be suitable for exposure to the elements.
  - 2. Connections made indoors shall use low smoke, low emissions "Cadweld Exolon" process.
  - 3. Buried or concealed joints shall be inspected and approved by the City of Santa Monica before concealment.
  - 4. All materials involved shall be from the same source to insure compatibility.
  - 5. Connections made with this process shall meet requirements of IEEE Standard 837 and other applicable specifications.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Grounding electrodes shall be located in the nearest usable planting area, and each electrode shall terminate within a concrete yard box installed flush with the finish grade in planting area, the concrete yard box shall be 2" above planting surfaces.
- B. Rods shall be driven to a depth of not less than 8'-0". Electrodes shall have a resistance to ground of not more than 5 ohms if practical. If the resistance exceeds 5 ohms, two or more electrodes connected in parallel shall be provided. The minimum number and size of ground rods shall be as required by the State Electrical Safety Orders. Each electrode shall be separated from each other electrode by not less than 6'-0". Paralleled electrode shall be connected together with approved fittings and approved grounding conductors in galvanized rigid steel conduit, buried not less than 12" below finish grade.
- C. Install a Ufer ground in addition to the ground electrode described above. The Ufer ground grounding electrode shall consist of a 50-foot length of bare 4/0 copper wire extended its full length below ground level and embedded along the bottom of the concrete foundation footing which is in direct contact with the foundation earth and supported in such a manner that

it cannot be less than 3 inches from the bottom or side of the concrete when the foundation concrete is poured. A loop at the approximate center of this grounding electrode shall be brought out at the top of the foundation and a 4/0 copper ground conductor shall connect the ground electrode to the main ground electrode bus in the equipment room. The conductor shall be connected to the ground electrode by exothermic welding.

- D. Transformers, generators, and other isolated neutrals shall be grounded from the neutral bushing or connector to main ground electrode.
- E. The interior metallic cold water system shall be bonded to the building steel.
- F. All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.
- G. All feeder runs and branch circuit wiring in non-metallic conduit shall carry a green TW insulated CEC sized ground conductor per circuit properly connected for electrical ground continuity.
- H. All feeder conduits shall contain an equipment ground conductor with 600 volt green insulation.
- I. All feeder conduits for 120/208V distribution boards and panelboards shall contain an isolated ground conductor in addition to green ground conductor. Isolated ground conductor shall be green with yellow stripe.
- J. Flexible conduit shall not be used as a ground path. Include CEC sized green conductor in all flex conduit.
- K. Provide CEC approved bonding devices, fittings or jumpers at expansion fitting, isolation sections or wherever continuity of ground is broken.
- L. Provide ground bars in all electrical and communications rooms. See drawings for ground bar and conductor sizes.
- M. Install grounding and bonding conductors with sufficient slack to avoid breaking due to settlement and movement of conductors at attached points.
- N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coating has been destroyed, which are subjected to corrosive action.
- O. Resistance to ground for electrical systems shall not exceed 5 ohms measurement and additional grounding shall be provided to attain this value or lower.

END OF SECTION

## SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections and the following, apply to this section:
  - 1. Section 260500, COMMON WORK RESULTS FOR ELECTRICAL.
  - 2. Section 260533, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.

#### 1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Requirements: The following contain requirements that are related to this Section:
  - 1. Divisions 3, 5 and 7.
  - 2. Refer to other Division 26 Sections for additional support requirements that may be applicable to specific items.

#### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
  - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.

#### 1.4 QUALITY ASSURANCE

- A. Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Installation shall comply with local authorities seismic requirements.

### PART 2 - PRODUCTS

#### 2.1 COATINGS

- A. Coating: Supports, support hardware, U-channel systems and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.



## 2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: U-channels, clevis hangers, riser clamps, threaded mild steel rods, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
  - 1. Preset inserts.
  - 2. Expansion Anchors: Carbon steel wedge or sleeve type.
  - 3. Toggle Bolts: All steel springhead type. Verify use with inspecting authority.
- C. U-Channel Systems: 16-gage steel strut channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

## 2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-Channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts or screws to form rigid supports.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with Code requirements.
- B. Coordinate with the building structural system, and with other electrical, HVAC and Plumbing Systems installations.
- C. Support vertical conduits passing through sleeves with UL approved riser clamps secured to the conduit and resting on the building structure. Support vertical conduits 1-1/4" and larger a minimum of once, and on 15' centers maximum. For vertical conduits smaller than 1-1/4" provide standoffs on 8' centers maximum. Support conduits adjacent to walls with preformed channels. Support freestanding risers with conduit racks of angle iron or channel iron members, rigidly bolted or welded together, and adequately braced.
- D. Install rigid steel conduit with threaded couplings. Support conduits 1" and larger on 10' intervals, smaller than 1" on 7' intervals, all sizes within 3' of connection to box, cabinet, or fitting.
- E. Support electric metallic tubing on maximum spacing of 10' and within 3' of connection to box, cabinet, or fitting including couplings.
- F. Support flexible metal conduit on 4' intervals within 1' of outlet box or fitting (except at connections to recessed lighting fixtures) and within 2' of vibrating equipment.
- G. Support gutter and wire-ways at 5' intervals and at changes of direction in a manner to allow full access.
- H. Attach to plaster, dry wall, or hollow masonry walls with metal toggle bolts.
- I. Attach to solid masonry walls with steel wedge anchors.
- J. Do not fasten rigid conduit or tubing to equipment subject to vibration or mounted on shock mounts.

- K. Secure conduits 1-1/4" and smaller to steel deck where permitted by Architect with cast or malleable iron conduit clamps and 1" minimum cadmium plated or galvanized sheet metal screws.
- L. Where attaching to steel members, use beam clamp, welded threaded studs, or machine screws.
- M. Where not otherwise specified herein, support all sizes of suspended conduit from beams or girders with factory made pipe hangers with split hinged malleable iron or springable steel pipe rings and solid round mild steel rods, 1/4" diameter for up to 1-1/4" conduit, 3/8" diameter up to 2" conduit, and 1/2" diameter for larger conduit. Where required conduit support spacing is more frequent than structural members, provide intermediate steel support as required.
- N. Provide trapeze type hangers where three or more conduits run parallel and clamp conduit to hanger with galvanized steel conduit clamps. Provide diagonal seismic bracing for suspended runs of conduits 2-1/2" trade size and larger when code requires. Utilize u-channels for trapeze assemblies. Lathing channels are not acceptable.
- O. Provide plated or galvanized hangers, threaded rods, channels and metallic support and fastening material or provide two coats of rust resistant paint, in' all damp or corrosive locations (e.g., vehicle maintenance garage, labs).
- P. Do not use perforated metal strap or wood as support material.
- Q. Support conduit to structure above suspended ceilings 3" minimum above ceiling to allow removal of tile. Do not support from T-bars or T-bar hanger wires. Maintain 2" clearance above recessed light fixtures.
- R. Above fixed ceilings and in stud walls, tie conduit 1" or smaller to furring, support channels capable of carrying the weight, or studs with No. 16 gauge galvanized wire ties 4' on center, maximum.
- S. Attach to precast or pre-stressed concrete as described under applicable sections of the specifications. Coordinate installation of precast u-channels or inserts where required, or obtain written approval from the Architect of alternate support methods.

END OF SECTION

SECTION 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The Contractor shall provide conduits and raceways as required and as specified.

1.2 SHOP DRAWINGS, PRODUCT DATA AND SAMPLE SUBMITTALS

- A. Manufacturer's catalog sheets.
- B. Metal gauges, size and finish.

1.3 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
- B. ANSI C80-3 - Electrical Metallic Tubing, Zinc-Coated.
- C. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- D. NFPA 70 - California Electrical Code (CEC).
- E. FS WW-C-563A - Electrical Metallic Tubing.
- F. FS WW-C-566 - Specification for Flexible Metal Conduit.
- G. FS WW-C-581 - Specification for Galvanized Rigid Conduit.
- H. NEMA RN 1 - PVC Externally-Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.
- I. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- J. UL 797 - EMT.
- K. Materials and/or installation shall meet or exceed the above referenced standards.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rigid Metallic Conduit: Provide standard weight steel that is hot-dipped zinc galvanized, or sherardized both inside and out after threading, with threaded connectors and couplings. Electrogalvanizing is not permitted. Intermediate Metal Conduit, IMC, will not be permitted. Manufactured by Allied tube and conduit, Western or equal.
- B. Rigid Steel Conduit Fittings: Fitting shall be all steel and zinc coated, ferrous metal and threaded type.
- C. Electric Metallic Tubing (EMT): Provide tubing of high grade steel electrically welded with exterior protective coating of hot galvanized zinc, applied by the electrogalvanized process. Then a secondary coating shall be applied to provide further protection against corrosion and abrasion. The interior wall of conduit shall be coated with corrosion resistant aluminum lacquer or enamel. Manufactured by Allied Tube and Conduit, Triangle, Republic, or Western.
- D. EMT Fittings: Fitting shall be watertight, gland ring compression type, wrench tightened connectors and couplings. Couplings and connectors shall be compression type and wet listed when used out doors or in wet environments. Screw type are acceptable in dry loca-

- tions only. Indenter and Die Cast (malleable iron) will not be acceptable. Manufactured by O-Z Gedney or Raco Model #2900 Series (2923 for 3/4" conduit).
- E. Aluminum Conduit: No aluminum conduits.
  - F. Flexible Steel Conduit: Provide conduit manufactured from single strip, standard weight steel hot-dipped galvanized on all four sides prior to conduit fabrication. Flexible aluminum will not be allowed.
  - G. Flexible Conduit Connectors and Couplings: Provide die cast fittings of the type that screw into the inside of the conduit with threaded edges at 90 degrees to the fitting body to insure a force fit. Binding screw type will not be acceptable. Manufactured by O-Z Gedney, T&B, Steel City or equal.
  - H. Flexible Liquid-tight Steel Conduit: Liquid-tight conduit shall be manufactured from single strip standard weight steel, hot dipped galvanized on all four sides prior to conduit fabrication, and shall be provided with an extruded polyvinyl chloride cover. Liquid-tight conduit and fittings shall provide positive ground continuity. Include a separate ground conductor for each circuit. Manufacturer "Sealtite Flexible" Type "UA," "Flex-Seal" Type "XL," or equal.
  - I. Flexible Liquid-tight Fittings: Fittings shall be malleable iron, zinc plated, with locknut and O-ring seal and slim diameter with small turning radius. Manufactured by O-Z Gedney-4Q series, T&B-5200 series or Appleton Flexible Fittings-ST series or equal.
  - J. Rigid Plastic Conduit: Provide heavy wall, 90 deg C rated, virgin polyvinyl chloride Schedule 40 and Schedule 80 with solvent welded joints, conforming to Underwriters Laboratories, Inc. (U.L.) requirements, listed for exposed and direct burial application.
  - K. Rigid PVC Fittings: fittings and cement shall be provided by same manufacturer. All joints shall be solvent welded in accordance with the manufacturer's recommendations. The interior of conduit and fittings shall be coated with urethane coating (two mil. Thickness) to protect against corrosion. Manufactured by Robroy Industries "Plasti-Bond red", Ocal Corporation "Ocal-Blue" or equal.
  - L. PVC Jacketed Conduits: Rigid steel conduits and fittings with a half lap, 40 mil extruded PVC jacket. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion.
  - M. Sleeves shall be zinc coated galvanized steel pipe or 16 gauge galvanized sheet metal or case in place firestop device.
  - N. Sealant: Fire rated equal to wall or ceiling penetrated. Silicon foam Dow-Corning #2001, 3M, "Pencil #851," or approved equal. Sealant compound for exterior wall shall be moisture-resistant material made by 3M, GE, Dow-Corning or equal.
  - O. Anchors not cast into concrete shall be expansion shield type, Phillips "Red Head," Hilti, or equal.
  - P. Conduit seals shall be Crouse-Hinds Type "EYS" or EZS," Appleton Type "ESUF" or "ESUM," or equal, with sealing compound as recommended by the manufacturer for hazardous or refrigerated areas.
  - Q. Expansion couplings shall be OZ Type "AX" or "DX," Crouse-Hinds Type "XJ" or "SD" or equal, complete with bonding jumper.
  - R. Conduit unions shall be "Erickson" couplings manufactured by Thomas and Betts, Type 4-Series manufactured by O-Z/Gedney or equal.
  - S. No conduit shall be smaller than 1/2-inch unless noted otherwise.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Installation of raceways shall be coordinated with building structure and work specified in other sections, and shall be complete with bends, fittings, junction and pull boxes to meet all codes and make complete operating systems.
2. Provide the type of conduit permitted in these Specifications or required for each location or condition per applicable codes and jurisdictions whichever is more stringent.
3. Conduit or MC cable shall be continuous from outlet to outlet, from outlet to cabinet, junction box, pull box and shall enter and be secured to all boxes, etc., in such a manner that each system will be mechanically and electrically continuous from service to all outlets.
4. Junction boxes or pull boxes shall be installed to avoid excessive runs and bends between outlets.
5. Conceal conduit above ceiling, below floors or in walls, unless otherwise noted.
6. A separate conduit shall be installed for each homerun indicated on the Drawings.
7. From each panel which is flush mounted in a wall, stub from top of the panel, a minimum of four 1-inch conduits to the nearest ceiling space or other accessible location and cap for future use.
8. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables. Support pullboxes from structure independent of conduit supports, with spacing not to exceed 200 feet. These pullboxes are not necessarily indicated on drawings. Pull boxes shall be provided for every 100 feet of telecommunications conduit runs.
9. Conduit support shall be dedicated to support the conduit system only and shall not support any other item.

#### B. Size of Conduits:

1. The size of the conduits for the various circuits shall be not less than required by California Electrical Code (CEC, Chapter 9 and appendix "C", Table "C1", based on "THW") for the size and number of conductors to be pulled therein. CEC requirements shall prevail.
2. No conduit shall be smaller than 3/4" unless otherwise noted.
3. Conduit size shall be increased to facilitate the pulling of wires.
4. Conduit size shall be increased to the next larger size where it shall be installed in slab or underground.
5. Minimum conduit size for underground shall be 3/4".
6. Minimum conduit size for medium voltage cable shall be minimum size per NEC code.

#### C. Application:

1. Provide EMT conduit for all sizes up to 4-inches in dry location as in stud partitions and furred ceiling space (up to 4" may be used for Telecommunications and up to 1-1/2" may be used for fire alarm system except for main run and riser).. EMT conduit shall not be used for underground, exterior, where it is prohibited and where rigid steel conduit is required.
2. Rigid steel conduit shall be used for the following:
  - a. Where required by Code.
  - b. Where exposed to weather.
  - c. Where exposed and below 7'-6" of above finished floor.
  - d. Where exposed to physical damage.
  - e. In corrosive area.
  - f. In damp and wet locations.

- g. In the utility tunnel.
- 3. Flexible steel or light weight steel conduit shall be used in dry locations where indicated, and as follows:
  - a. Where required by Code.
  - b. For connection to recessed light fixture from junction box or pull box, maximum 6'.
  - c. Where structural condition prevents the use of other type of conduit (maximum 24").
  - d. For final connection to motor, transformers, any vibrating equipment and where required for equipment serving. Maximum 36" and minimum 24".
  - e. Minimum length of flexible steel or light weight steel conduit shall be 24" and maximum 72" unless otherwise noted.
- 4. Flexible liquid-tight conduit shall be installed in lieu of the flexible steel, as follows:
  - a. Where required by Code.
  - b. In damp and/or wet location.
  - c. Where exposed to weather.
  - d. In refrigerated area (65°F or less).
  - e. Between the seismic joints.
  - f. For connections to electric water heaters.
  - g. Any connections made below sinks.
  - h. Minimum length of flexible liquid-tight conduit shall be 24" and maximum 72" unless otherwise noted.
- 5. Rigid plastic conduit PVC Schedule 40 may be used as follows:
  - a. For 2" and larger size encased in concrete at minimum 36" below grade for outside of building envelope only (5 feet outside of building line), unless otherwise noted.
  - b. For non-emergency wiring system and 1-1/2" and smaller size surrounded with 3" sand all around the conduit at minimum 24" below grade for outside of building envelope, or at minimum 12" below finished floor for inside of building envelope.
  - c. For emergency wiring system and 1-1/2" and smaller size encased in 3" concrete at minimum 24" below grade for outside of building envelope, or at minimum 12" below finished floor for inside of building envelope.
- 6. Rigid plastic conduit PVC Schedule 40 shall be used for all underground conduit runs installed under the building. Conduits shall be encased in concrete, minimum 36" below finished floor unless otherwise noted.
- 7. Provide a green insulated ground conductor of size as required by Code in all flexible and PVC conduit runs.
- 8. Flexible conduit shall not be used in lieu of EMT or rigid conduit. PVC Jacketed Steel Conduits:
  - a. Use PVC jacketed steel conduit for all underground conduits stubbed up through the floor in lieu of PVC.
  - b. Cut threads on conduits to standard taper and to a length such that all bare metal exposed by the threading operation will be completely covered by the couplings or fittings used. Securely tighten all threaded connections.
  - c. Wrap all joints with two layers of 10 mil PVC tape.
  - d. All conduits and fittings which have a damaged PVC coating shall be replaced or repaired at Contractor's expense.

D. Conduit Placement:

- 1. Support conduits 1-inch and larger with pipe clamps either suspended from structural slabs with a rod at least 3/8 -inch diameter with adjustable pipe ring, or mounted on

- wall form channel supports. Attach to concrete with Phillips "Red Head," Hilti, or equal drilled anchors or poured in place anchors of appropriate load capacity. Where two or more conduits 1-1/2 inch and larger are suspended from ceiling, use trapeze type hanger suspended from rods.
2. Where rigid metal conduits and electrical metallic tubing are supported from Building members, supports shall be installed as follows:
    - a. Conduit Sizes:
      - 1) 3/4" to 1-1/4" Within 18" of each outlet inclusive: and on either side of couplings and fittings and at a spacing not to exceed 10 feet.
      - 2) 1-1/2" and larger Within 3 feet of each junction or pullbox and terminal cabinet and at a spacing not to exceed 10 feet.
    - b. When conduits are supported from trapezes, the supports shall be spaced not more than 10 feet apart.
    - c. Conduit trapezes shall consist of suitable Unistrut or Kindorf fittings, or equal, in accordance with the manufacturer's printed recommendation.
  3. Secure exposed conduit runs on concrete, plaster or other construction in place with cast conduit clamps affixed with metallic expansion anchors or toggle bolts and cadmium plated machine or lag screws.
  4. All exposed conduits shall be installed parallel to and perpendicular to the building structure.
  5. Conduits which are installed above dry type or suspended ceilings shall not be secured to ceiling support wires. Support such conduit independent of ceiling suspension systems.
  6. Support conduit to structure above suspended ceilings 8" minimum above ceiling to allow removal of ceiling tile. Do not support from T-bars or T-bar hanger wires. Maintain two inch clearance above recessed light fixtures.
  7. Support conduits adjacent to walls with preformed channels.
  8. Provide plated or galvanized hangers, rods, #10 ceiling wire, channels and metallic support and fastening material.
  9. Exposed conduit larger than 1 inch shall be suspended with pipe hangers. Pipe hangers for individual conduits shall be Grinnell #108 and #110R, Super Strut #M-718-5R, or equal, malleable iron split pipe rings, suspended from hanger rods. Rods shall be three-eighth (3/8)-inch for two (2)-inch and smaller conduits, and one-half (1/2)-inch for two and one-half (2-1/2)-inch and larger conduits. Hangers and racks shall be attached to concrete with insets, set at the time the concrete is poured, and to steel members with beam clamps or machine bolts.
  10. Conduit clamps and hanger rods attached to concrete structures shall be secured by machine bolts or rods screwed into anchors. Anchors not cast into the concrete shall be of the expansion shield type, Phillips "Red Head," Hilti, or equal.
  11. Provide independent support for all conduits rising from floor for motor connections if over 18 inches above floor.
  12. Do not support any conduit to motor, ductwork or mechanical equipment.
  13. Conduit shall not be run closer than 12 inches to any hot water pipe, steam pipe, heater flue or vent. Maintain minimum 6" inches clearance between conduit and other piping.
  14. Conduits in furred spaces shall be routed to clear access openings.
  15. Where steel conduits enter a concrete floor below a surface mounted panelboard, they shall be encased in a concrete curb of sufficient height to match the height of the finished base tile.
  16. Holes for conduits through existing concrete walls, manhole, or floors shall be made by the "core-drill" method.
  17. Upon completing the installation of any run of conduit, the runs shall be tested to see that they are free from all obstructions and have a smooth interior.

E. Duct Bank:

1. Encase all nonmetallic conduit installed underground in a 3-inch concrete envelope unless otherwise noted. Extend concrete envelopes a minimum of 3 inches beyond all external sides of all outermost conduits. Space the external surfaces of all conduit within a bank, a minimum of 3 inches apart. All signal circuits (including telephone, data, alarm, sound, etc.) contained within nonmetallic conduit shall have a minimum separation of 12 inches from any light or power circuits that parallel them within a bank.
2. Use manufactured concrete or plastic spacers to insure required concrete coverage. Concrete shall be 2500 psi. Concrete for duct banks containing conduits for electrical cables shall have "red oxide" (6LBS/CY of concrete) added to the wet concrete mix to provide a distinctive red color to the entire concrete envelope. At building entry point provide tags on all conduits clearly stating "CAUTION -- HORIZONTAL RUNS EXTERIOR TO BUILDING ARE PLASTIC."
3. Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 4 inches in 100 feet. 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, except that manufactured bends may be used at ends of short runs of 100 feet or less, and then only at or close to the end of run.
4. Underground conduits, which terminate inside building below grade, or which slope so that water might flow into building, shall be sealed at termination after installation of conductors. Install plugs or caps in spare (empty) conduits. Provide 4% slope to outside the building where possible to drain the water.

F. Seismic Bracing:

1. Provide seismic bracing for conduits (3) 3/4", or (2) 1", and/or (1) 1-1/2" and larger or multi size combination, wherever conduit is suspended more than 10" to the bottom of the conduit from its anchoring point on the structure. All such bracing as described herein or below shall be run from the raceway to the structure, and anchored to the latter in an approved manner.
2. Provide diagonal bracing every 16' to the structure from hangers and changes in direction.
3. Seismic bracing shall meet and exceed Title 24 and other code requirements.
4. Seismic bracing as described above shall be provided immediately upon completion of each conduit run, to prevent obstruction of conduits by other utilities or construction work.

G. Paint:

1. All exposed conduits in the public areas shall be painted to match the background color as directed by Architect. Paint shall be in accordance to Division 9.
2. All exposed conduits above service carriers, electrical and mechanical rooms are exempted.

END OF SECTION



## SECTION 26 05 36 – CABLE TRAYS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide cable trays as shown on the Drawings and as specified.

#### 1.2 SHOP DRAWINGS AND PRODUCT DATA SUBMITTALS

- A. The following list includes the required shop drawings and product data that shall be submitted:
- B. Manufacturer's standard catalog sheets for wireways and accessories indicating:
  - 1. Cross sectional dimensions.
  - 2. Gage of metal.
  - 3. Construction.
  - 4. Radius of bends.
  - 5. Finish.
  - 6. Manufacturer's structural loading chart.
  - 7. Underwriters Laboratories Inc. (UL) label.
  - 8. Compliance with National Electrical Manufacturer Standard VE-1.
- C. Structural Support System:
  - 1. Cross sectional dimensions.
  - 2. Gage of metal.
  - 3. Finish.
  - 4. Details of support assembly and support points.
  - 5. Structural strength of devices.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

#### 1.3 REFERENCES

- A. ANSI/NFPA 70 - California Electrical Code.
- B. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.
- C. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.
- D. NEMA FG 1 - Fiberglass Cable Tray Systems Standards.
- E. NEMA VE 1 - Metallic Cable Tray Systems Standards.
- F. Materials and/or installation shall meet or exceed the above referenced standards.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Wireways:
  - 1. Wireways shall be NEMA class 12B, Ladder Type, 6"D x 12"W (or as indicated on drawings) and 9" o.c. rung spacing, straight sections, connectors and elbows as specified. Routing and lengths as shown on the Drawings. Wireway shall be capable of supporting

- 125 pounds of cable per lineal foot. Products shall be manufactured by T.J. Cope-Tray or P-W Industries.
  2. All horizontal and vertical elbows shall be with 12" minimum radius.
  3. Provide blind end at cable tray end point.
- B. Supports:
1. Beam clamps of 1/2-inch threaded galvanized rod with anchor clips shall be Kindorf "Beam Clamp", "Unistrut" or equal.
  2. One-half inch diameter threaded rod shall be galvanized steel.
  3. Steel channels shall be 14 gage 1-1/2 inches by 1-1/2 inches with 17/32-inch diameter holes, 1-1/2 inches on center, manufactured by Kindorf, Unistrut, or equal.
- C. Penetrations:
1. For all Cable Tray penetrations through wall or partition use prefabricated wall sleeve with adjustable collar.
  2. For penetrations through smoke or fire rated walls use suitable fire stopping materials in voids to seal fully against and between cables manufactured by Dow-Corning or 3M.
  3. For penetrations through Acoustic walls use moldable putty in voids to seal fully against and between cables, manufactured by Nelson or 3M.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Securely fasten cable trays to structural members. Provide additional elbows, bends, connectors and any other type fittings and support to install the cable tray for best possible location in the available space. Refer to Section 26 05 00 - Location and Routing.
- B. Provide fire or sound barriers where cable trays penetrate fire or sound rated Building components.
- C. Furnish and install a #2 American Wire Gage (A.W.G.), insulated copper ground conductor in each cable tray. Connect each section of cable tray to the ground connector. The ground connector shall be connected to ground bus at each terminal board.
- D. Install in accordance with manufacturer's instructions and in accordance with NEMA VE 1.
- E. Use expansion connectors where required.
- F. Cable trays shall have min. clearance of 12" on top and at each side after installation.
- G. Power feeders of greater than 130 volts to ground should not be run parallel to the cable tray. Parallel runs of greater than 20 feet require a minimum separation distance between conduit and nearest point of the cable tray of 18 inches, and 9 inches for runs of less than 20 feet.
- H. All power feeders crossing the path of the cable tray at right angles shall be a minimum of 6 inches in distance from the nearest point of the cable tray, in order to prevent problems with high-speed data transmissions.
- I. There shall be an 12-inch separation between the nearest point of the cable tray and the fluorescent light fixtures.
- J. Provide seismic bracing for cable tray to structural element every 20 feet with steel channel to carry out 800 pounds and seismic restraints as required by the code.
- K. Cable tray support shall be dedicated to cable trays. Do not support any other item with the cable tray support system.
- L. Provide additional elbow, and double elbow (offset) as required base of building structural, limited space and of other equipment in cabling space because of limited space available.

M. Provide cable tray in all telephone/data rooms.

END OF SECTION

SECTION 26 05 48 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Work included in this Section. Principal items of work include the following:

1. Vibration isolation of transformers.
2. Vibration isolation of distribution panels connected to transformers.
3. Vibration isolation of lighting inverter.
4. Flexible conduits at transformer connections.
5. Flexible conduits at connections to motors and other vibrating equipment.
6. Electrical box-pads at stud partitions where sound insulation is provided.
7. Vibration isolation of suspended raceways at specified locations.
8. Vibration isolation of unit substations.
9. Seismic restraint for vibration isolated equipment.

1.2 GENERAL REQUIREMENTS

A. Coordination

1. The contractor shall coordinate his work with other trades to avoid rigid contact between isolated transformers, raceways and the building. He shall inform other trades following his work to avoid any contact which would reduce the vibration isolation.

B. Conflicts and Discrepancies

1. The contractor shall bring to the architect's attention prior to installation any conflicts with other trades which will result in unavoidable contact to the equipment, raceways, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
2. The contractor shall bring to the architect's attention any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.

C. Inspection and Instruction

1. The contractor shall obtain inspection and approval from the architect of any installation to be covered or enclosed prior to such closure.
2. The contractor shall obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

1.3 SUBMITTAL

A. Reference shall be made to general conditions for requirements pertaining to submittals, including preparation and transmittals. The submittal shall contain the following information:

1. Catalog cuts and data sheets on specific vibration isolators, mufflers, electrical box pads and other equipment to be utilized, showing compliance with the specification.
2. An itemized list showing the items of equipment to be isolated, the isolator type and model number selected, isolator loading and deflection.
3. The contractor shall obtain written and/or oral instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

1.4 ISOLATOR CONFIGURATION FOR FLOOR MOUNTED OR SUSPENDED EQUIPMENT

- A. A maximum of four vibration isolators shall be provided, located at the corners of the equipment unless approval is obtained for additional isolators.

1.5 SEISMIC RESTRAINT REQUIREMENTS

- A. Seismic restraint shall be furnished and installed in accordance with all relevant State and local code requirements.

1.6 RESPONSIBILITY OF MANUFACTURER

- A. Vibration isolation manufacturer shall have the following responsibilities:
  - 1. To determine vibration isolation sizes and locations.
  - 2. To provide equipment isolation system as scheduled or specified.
  - 3. To guarantee specified isolation system deflection.
  - 4. To provide installation instructions and drawings.
  - 5. To provide calculations signed by a structural engineer licensed in the State in which the work is to take place certifying that the seismic restraints will act in accordance with the relevant State and local codes and will maintain equipment in captive position.

1.7 VIBRATION ISOLATION AND NOISE CONTROL REQUIREMENTS

- A. Floor Mounted Transformers:
  - 1. Type E, 0.15 inch static deflection.
  - 2. Locate at 4 corners of transformer.
  - 3. Bolt to floor.
  - 4. Wall mounted not permitted.
- B. Lighting Inverter:
  - 1. Type E, 0.15 inch static deflection.
  - 2. Locate at 4 corners of Lighting Inverter.
  - 3. Bolt to floor.
- C. Distribution Panels Connected to Transformers:
  - 1. Floor mounted connected to adjacent transformers within buildings by flexible conduit.
  - 2. Type E, 0.1 inch static deflection.
  - 3. Locate at 4 corners.
  - 4. Wall mounted not permitted.
- D. Flexible Electrical Connections:
  - 1. At all transformers within buildings.
  - 2. At connections to motors or other vibrating equipment.
- E. Suspended Raceways between Unit Substations and Distribution Panels:
  - 1. Within unit substation electrical equipment room only.
  - 2. Type F isolation hangers, 0.2 inch static deflection.
  - 3. Provide seismic restraints.

1.8 ELECTRICAL BOX PADS

- A. Provide at all junction boxes located within sound insulated drywall partitions.

## PART 2 - PRODUCTS

### 2.1 VIBRATION ISOLATORS

#### A. General Properties

1. All vibration isolators shall have either known undeflected heights or other 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.
2. 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 50% above the design deflection.
3. The ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 2.0.
4. The vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than + or - 10%.
5. All vibration isolation equipment exposed to moisture or an outdoor environment shall be coated as follows:
  - a. All steel parts to be hot-dipped galvanized.
  - b. All bolts to be cadmium plated.
  - c. All springs to be cadmium plated and neoprene coated.

#### B. Isolator Types and Descriptions.

1. Type E is a neoprene isolator capable of resisting a seismic load of 1.0 G in all directions. The mount shall consist of a captive steel insert embedded into a neoprene element which is enclosed by a steel housing which also includes floor mounting holes. The isolator shall have a rated deflection of 0.15 inches in compression, 0.12 inches in tension and 0.09 inches in shear.
2. Type F is a suspension hanger with a steel box frame and a molded neoprene in shear element. A neoprene grommet shall be provided at the location where the hanger rod passes through the hanger box so that no metal-to-metal contact occurs.

### 2.2 FLEXIBLE CONNECTIONS

- A. Conduit over 1 inch OD: Make electrical connections to vibrating equipment via flexible expansion/deflection conduit coupling sized as required. Coupling shall have a flexible and watertight outer jacket, an internal grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit. Acceptable units include:
  1. XD Expansion Deflection Coupling by Crouse-Hinds of Syracuse, N.Y.
  2. Type DF Expansion and Deflection fitting by Spring City Electrical Mfg. Co. of Spring City, PA.
- B. For conduit under 1 inch OD: Use "flexible" conduit with slack at least 3 feet or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

### 2.3 ELECTRICAL BOX PADS

- A. Equal to Lowry's Outlet Box Pads as manufactured by Harry A. Lowry Associates, Sun Valley, California.

### 2.4 SEISMIC RESTRAINTS

- A. Suspended Vibration Isolated Raceways.
  1. A slack cable system shall be used.

2. The cable size, location and attachment to the raceway and structure shall be approved with calculations signed by a structural engineer licensed in the State in which the work is to take place.
  3. Submittal drawing shall indicate proposed method of vertical restraint.
  4. Cable shall be installed with sufficient slack to avoid short circuiting the vibration isolation.
- B. Vibration Isolated Distribution Panels.
1. Isolation mounts shall be provided with integral seismic restraints.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF VIBRATION ISOLATION DEVICES

- A. Transmission of perceptible vibration or structure borne noise to occupied areas by equipment installed under this Contract will not be permitted.
- B. Vibration isolators shall be installed per manufacturer's directions.
- C. Use of vibration isolators for Lighting Inverter shall be coordinated with Lighting Inverter supplier.
- D. Flexible electrical connections:
  1. Installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the aforementioned vibration isolation.
  2. Option 1: Install the flexible conduit in a grossly slack loop form or shallow "U" form. Install the stranded conductors with sufficient slack to accommodate maximum possible movement.
  3. Option 2: The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack and free of strain in any direction. Install stranded conductors as above.
- E. All vibration isolation devices, including auxiliary steel bases shall be designed and furnished by a single manufacturer or supplier, who will be responsible for adequate coordination of all phases of this work.
- F. The vibration isolation manufacturer, or his representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the Architect in writing, certifying the correctness of installation and compliance with approved submittal data.
- G. Vibration Isolation Hangers:
  1. The isolators shall be installed with the isolator hanger box as close as possible to the structure.
  2. Hanger rods shall be aligned to clear the hanger box and be plumb.

#### 3.2 OUTLET BOX PADS

- A. All holes in outlet boxes in sound rated walls shall be completely covered with electrical box pads molded and pressed to the back side of the box.

#### 3.3 COORDINATION

- A. The contractor shall coordinate his work with other trades to avoid rigid contact between isolated equipment and raceways with the building. He shall inform other trades following his work to avoid any contact which would reduce the vibration isolation.

END OF SECTION



## SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS AND LIGHTING CONTROLS

### PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions and Division 01 are fully applicable to this Section, as if repeated herein.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 019113, General Commissioning Requirements
- B. Division 26 Sections pertaining to Electrical Systems
- C. Division 26 Sections pertaining to Lighting Controls:
  - 1. 26 09 36 – Modular Dimming Controls
  - 2. 26 27 26 – Wiring Devices

#### 1.03 REFERENCES

- A. USGBC:
  - 1. LEED – NC 3.0: EA Prerequisite 1, Fundamental Commissioning.
  - 2. LEED – NC 3.0: Credit 3, Enhanced Commissioning.

#### 1.04 DEFINITIONS

- A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned. The BOD is prepared by the Design Professionals.
- B. Building Automation System (BAS): The automated building system providing control and user interaction with select building systems, such as the HVAC, DHW and lighting systems.
- C. Commissioning Authority (CxA): An independent agent hired directly by the Owner and not otherwise associated with the Design Professional(s) or the Contractor. The CxA assists the Contractor with coordinating commissioning activities and witnesses the activities on behalf of the Owner.
- D. Commissioning Issue (Cx Issues): A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.
- E. Commissioning Issues List (Cx Issues List): A log maintained by the CxA listing all Deficiencies and Cx Issues documented during the commissioning process. All issues require action, correction and closure.
- F. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail.
- G. General Contractor (GC): The contractor directly contracted to the Owner with overall responsibility for the project and all commissioning activities described herein.
- H. Commissioning Coordinator (CxC): Individual within the General Contractor firm who plans, schedules, directs and coordinates all the Trade Sub-Contractor's commissioning activities, and serves as the CxA's single point of contact for all administrative, documentation and coordination functions.
- I. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion.

- J. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents. A Deficiency will be considered a Cx Issue and documented on the Cx Issues List.
- K. Functional Performance Test (FPT): A test of the dynamic function, operation and control sequences of equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, alarm, power failure, etc. The FPTs are performed using manual (direct observation) or monitoring methods.
- L. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components prior to Startup. IV process is complete when systems are ready for Startup. IV's are organized and documented under the System Readiness Checklist (SRC) forms.
- M. Monitoring: The recording of parameters (flow, current, status, pressure, etc) of equipment operation shall be completed using data-loggers or the Trending capabilities of BAS or control systems.
- N. Owner's Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and operated, and the equipment and system expectations and requirements, as defined by the Owner. This document provides an explanation of the ideas, concepts, goals, success criteria, and supporting information for the project.
- O. Percent Sampling: Witnessing the startup or testing of a selected fraction of the total number of identical or near-identical pieces of equipment.
- P. Pre-Functional Checks & Tests (PFC): These are various checks and tests performed on a piece of equipment or system just before, during or after the initial Startup and operation. They are performed to confirm that the equipment and individual components were installed correctly and are working properly. Examples include checking fan rotation, sensor calibration, actuator testing, and spot temperature, pressure and electrical measurements. They also include system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system test and balance and electrical equipment NETA testing. They are organized under the System Readiness Checklist (SRC) forms and must be completed prior to FPTs.
- Q. Startup: Initial starting or activating of equipment usually performed by the Trade Sub-Contractor or the Manufacturer's authorized representative.
- R. System Readiness Checklist (SRC): A summary checklist, typically one page per equipment, covering the necessary commissioning tasks and required documentation to verify that a system is ready for FPTs, or system operation if no FPTs are performed. The tasks covered in the SRC include IV, Startup and PFC, and the Trade Sub-Contractor completed forms for these tasks are attached to the equipment specific SRC. The SRC must be completed and signed by the General Contractor prior to conducting the FPTs.
- S. TAB: Testing, Adjusting, and Balancing work on the air and water systems to ensure design flow conditions are met. Performed by the TAB Trade Sub-Contractor.
- T. Trade Sub-Contractor: Typically a subcontractor to the General Contractor who provides and installs specific building components and systems and/or provides certain services.
- U. Trending: Monitoring using the Building Automation System (BAS) or a control system, to aid in functional testing and to verify system operation and performance under actual operating conditions.

1.05 DESCRIPTION OF WORK

- A. Systems and equipment to be commissioned:
  - 1. Lighting Controls
  - 2. Photovoltaic (PV) System
- B. The work includes the completion and documentation of formal commissioning procedures by the General Contractor and Trade Sub-Contractors.
  - 1. Commissioning (Cx) is defined as the process of verifying and documenting the installation and performance of selected building systems to meet the specified design criteria and contract documents, thereby satisfying the design intent and the Owner's requirements and operational needs.
  - 2. The Design Professionals, General Contractor and Trade Sub-Contractors will provide the quality control for the design, installation, startup and checkout of the systems. The commissioning process provides review and qualitative functional testing in order to formally observe and document that the quality control efforts are successfully completed.
  - 3. Refer to Section 019113, General Commissioning Requirements for summary description of the general commissioning process and requirements.
  - 4. The Trade Sub-Contractors and the factory authorized service representatives shall be responsible for participation in the commissioning process as outlined in this specification and Section 019113 General Commissioning Requirements, and as directed by the General Contractor's Commissioning Coordinator (Cx/C) as overseen by the Commissioning Authority (Cx/A).

1.06 COMMISSIONING PROCESS

- A. Submittal Review by the CxA
  - 1. The CxA will review the Trade Sub-Contractor's submittals for the appropriate systems in the commissioning scope, concurrently with the Design Team and will provide review comments to the Design Team.
  - 2. The General Contractor shall provide a submittal log to the CxA for referencing requested submittals to be reviewed by the CxA (for which the General Contractor shall issue to the CxA concurrently with the submission to the Design Professionals). Alternatively, the General Contractor shall include the CxA on the distribution of all Trade Sub-Contractor submittals issued to the Design Professionals, for systems applicable to this specification.
  - 3. The General Contractor shall ensure that the requested submittals for review by the CxA are issued to the CxA at the same time they are issued to the Design Team.
  - 4. Information from the submittals will also be used by the CxA to develop commissioning forms and test procedures.
- B. Cx Plan and Form Development
  - 1. The CxA prepares a Preliminary Cx Plan during the project final design phase. The Cx Plan provides guidance in the execution of the commissioning process during construction.
  - 2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the commissioning process and systems are reviewed. The Preliminary Cx Plan is presented and specific requirements and responsibilities are discussed and implemented.

3. The CxA develops the SRC forms which list and track the completion of the Installation Verification, Startup, and Pre-Functional Checks & Tests required for each system and equipment to be commissioned. The SRC forms are provided to the General Contractor and Trade Sub-Contractors for review and comment.
4. The CxC shall submit to the CxA, for review and approval, representative blank forms for completing Installation Verification, Startup, and Pre-Functional Checks & Tests.
  - a. Installation Verification forms are used to provide field verification and documentation of proper installation of equipment and system prior to formal Startup. Where appropriate, these forms may be combined with the Startup and Pre-functional Check & Test forms. And where appropriate, these forms can be checklists taken from the Manufacturer's installation manual.
  - b. Startup and Pre-Functional Check forms primarily consist of Manufacturer and Trade Sub-Contractor startup and checkout sheets and shall be used where required and appropriate. Where applicable, these forms shall include checks of the equipment controls including sensors and control devices.
  - c. The Pre-Functional Test forms shall also include forms for recording results from system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system TAB, electrical equipment NETA testing, etc.
5. The CxA will develop FPT procedures and forms. These test procedures are provided to the General Contractor and Trade Sub-Contractors for review and comment.
6. The CxA will update and finalize the Cx Plan with equipment specific documentation and SRC and FPT forms.

C. System Readiness Activities

1. Meetings will be conducted throughout construction with Commissioning Team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx Issues.
2. The Trade Sub-Contractors shall perform Installation Verification, Startup and Pre-Functional Check & Test activities, as part of the system readiness checks to verify that the system is ready for operation or functional testing. The Trade Sub-Contractors and the CxC shall document completion of these activities on the SRC forms and attach the completed Installation Verification, Startup, and Pre-Functional Check & Test forms to the SRC.
  - a. In general, Installation Verification should be completed prior to Startup, but where appropriate, they can be completed into one activity.
3. The CxA will perform various observation inspections during the installation phase and back-checks of the completed Installation Verification. The CxA will also witness a percent sampling of the Startups and Pre-Functional Checks & Tests, including TAB procedures.

D. Functional Testing

1. Functional Performance Tests (FPTs) are tests of the dynamic function, performance and control of the equipment and systems under various modes of operation. These tests are used to verify that the sequences of operation are correctly implemented and that the design intent criteria and performance of the systems have been met.

2. The CxA will develop FPT forms that contain:
  - a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.
  - b. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
  - c. A section for recording actual system response, notes and comments.
  - d. Any definitions of control system trend data to be collected and provided to the CxA in electronic format for analysis and review.
3. Once the SRC forms are completed, the FPTs are executed by the Trade Sub-Contractors and a sample are witnessed by the CxA, as defined in the Cx Plan. The FPTs may be achieved by any combination of manual testing, monitoring or trending.
4. Any deferred testing will be defined in the Cx Plan.

E. Deficiencies and Commissioning Issues

1. Throughout the process, the Commissioning Issues are recorded by the CxA on the Commissioning Issues List and distributed to the commissioning team. The General Contractor and Trade Sub-Contractors shall correct Commissioning Issues and retest the system(s), where applicable, without delay at no additional cost to the Owner. The CxA will verify the completion of the issues and make all amendments to the issues list.

F. O&M Manuals, Training Verification and Final Documentation

1. The General Contractor shall compile and complete the Operations & Maintenance (O&M) Manuals provided by the Trade Sub-Contractors, per the contract documents requirements. The CxA will verify that the O&M manuals have been delivered to the Owner per the contract requirements and may request electronic copies of the O&M Manuals to aid in the completion of the Systems Manual.
2. The General Contractor shall submit a training schedule and specific training agendas provided by the Trade Sub-Contractors for each training class, to the CxA and Owner for review prior to conducting any training. The CxA will review and provide comment to the Owner and General Contractor on the specified training agendas. The CxA will verify completion of the training by receiving a copy of the training sign-in sheets, provided by the General Contractor.
3. The CxA will develop the Systems Manual (for energy-related systems per LEED requirements) with assistance from the General Contractor and Trade Sub-Contractors. The systems to be included are the HVAC systems and controls, lighting controls, domestic hot water systems and controls, and any renewable energy systems.
4. The CxA will complete the Final Construction Phase Commissioning Report and documentation for the Owner with assistance from the General Contractor and Trade Sub-Contractors.

G. Post-Occupancy Warranty Phase Commissioning

1. No later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility O&M staff, walk the facility and review systems operation. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.

2. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period.

#### 1.07 COMMISSIONING TEAM

- A. The Commissioning Team is responsible for performing the process and achieving successful commissioning results. The Commissioning Team is comprised of the following:
  1. Owner and Owner's Representatives
  2. Design Professionals (DP)
  3. Commissioning Authority (CxA).
  4. General Contractor
  5. General Contractor's Commissioning Coordinator (CxC)
  6. Trade Sub-Contractors responsible for systems covered in this section include:
    - a. Electrical Contractor
    - b. Lighting Controls Contractor

#### 1.08 RESPONSIBILITIES

- A. General.
  1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend the commissioning kickoff meeting, and attend additional commissioning meetings as necessary.
- B. Commissioning Authority (CxA)
  1. See Section 019113, General Commissioning Requirements.
- C. General Contractor:
  1. See Section 019113, General Commissioning Requirements.
- D. Trade Sub-Contractors – General Requirements:
  1. Provide commissioning submittal data, including manufacturer's installation checks and startup procedures, commissioning forms, and any other requested contract documentation for systems to be commissioned. Electronic files are acceptable.
  2. Attend commissioning meetings as directed by the CxA and General Contractor's CxC to facilitate the commissioning process.
  3. Assign personnel with expertise and authority to act on behalf of the General Contractor and schedule them to participate in and perform assigned commissioning tasks.
  4. Demonstrate and document proper system installation, startup and performance. Complete all Installation Verification, Startup and Pre-Functional Check & Test documentation clearly and legibly. Provide a copy of all forms to the CxC and CxA as part of completing the SRC forms.
  5. Provide access for the CxA to witness any equipment Startup and Pre-Functional Checks & Tests. Notify the CxC and CxA at least 10 days in advance of Startup and Pre-Functional Checks & Tests.
  6. Ensure that any required manufacturer factory tests are performed and provide the factory test data and results where required.

7. Ensure that any required manufacturer's representative field tests and on-site installation verification, startup and checkout of selected equipment are performed per the contract documents. Provide completed manufacturer documentation and commissioning forms for these activities to the CxC.
8. Address Trade Sub-Contractor applicable Cx Issues and Deficiencies promptly. All Installation Verification, Startup and Pre-Functional issues must be resolved before the FPT can proceed.
9. Assist CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation are not sufficient for writing detailed testing procedures.
10. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits and overrides to be used during the tests.
11. As part of the FPTs, the Trade Sub-Contractor shall setup any additional software points, overrides of any sensor values or relays, and overrides of any setpoints or schedules, to simulate certain conditions and operating modes, in order to conduct the FPTs.
12. Perform the FPTs. Execution of FPTs shall be witnessed by the CxC and CxA and fully documented.
13. Prepare a training agenda for each training class (to be reviewed by the CxA) and work with the General Contractor and Owner to schedule training. Execute training of Owner's personnel per approved training agenda and schedule.
14. Prepare O&M Manuals according to the Contract Documents.
15. Assist the CxA in developing the Systems Manual.

E. Trade Contractors – Specific Lighting Controls Requirements

1. In addition to the general Trade Sub-Contractor responsibilities outlined above, the Lighting Controls or Electrical Trade Sub-Contractor responsibilities during commissioning shall include, but are not limited to:
  - a. Prior to any controls construction activity, provide approved submittals, including shop drawings, control drawings, points list and detailed sequences of operation for each piece of equipment and system to be controlled. The system sequence of operation shall fully describe their equipment components and functionality, including setpoints and alarm functions. The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the specification and/or drawings. Electronic files are acceptable.
  - b. Prior to any lighting controls Startup activity, provide the settings and time schedules to be used for the lighting controls and the process for determining any field adjustable settings, for the CxA and Design Professional (DP) to review. The target light levels for determining any day lighting minimum and maximum settings shall be obtained from the DP.
  - c. The Lighting Controls or Electrical Trade Sub-Contractor shall setup a field demonstration of the final lighting control settings (including field adjustable ones) for a few representative initial installations, for the CxA, Owner and DP to review prior to the completion of all controls.

- d. As part of the SRC activities, the Lighting Controls or Electrical Trade Sub-Contractor shall provide a floor plan or spreadsheet table checklist that indicates installation verification and pre-functional checkout of each local lighting control device, including occupancy sensors and day lighting controls. The intent of this checklist is to verify the installation of each device in the correct room or location per the Contract Documents, to verify installation per the manufacturer's instructions, to verify that device settings have adjusted and checked, and to verify that the operation and control has been tested by Trade Sub-Contractor. This Trade Sub-Contractor completed checklists shall be attached to the corresponding SRC form.
- e. The Lighting Controls, Electrical or BAS Trade Sub-Contractor shall also provide trend data to the CxA during the post-occupancy warranty phase for review by the CxA, where required.

#### 1.09 SUBMITTAL REQUIREMENTS FOR COMMISSIONING

- A. The Trade Sub-Contractors shall submit to the CxA representative, blank forms for Installation Verification, Startup and Pre-Functional Checks & Tests.
  - 1. The CxA will review these submitted commissioning forms for completeness including any project specific requirements.
  - 2. The CxA may request additional data, changes and/or additions to these forms to make sure they are complete prior to their use. If the submitted forms are not available or are not sufficient, then the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.
- B. The Trade Sub-Contractors shall submit to the CxA any equipment and construction submittals and shop drawings, including detailed sequences of operation, as requested by the CxA.

### PART 2 -PRODUCTS

#### 2.01 DOCUMENTATION

- A. The Trade Sub-Contractors have specific responsibilities for assisting in the development of equipment check, test and verification procedures and forms, and in performing and documenting commissioning tests, as directed by the CxC and as overseen by the CxA.
- B. The Trade Sub-Contractors shall provide, wherever the Contract Documents require, system checks and testing, test reports, factory test data and reports, checklists, operational verifications and demonstration, etc. , whether specified or not in the commissioning sections.

#### 2.02 TEST EQUIPMENT

- A. The Trade Sub-Contractor shall provide all test equipment to execute Pre-Functional and Functional Performance Tests.
- B. The test equipment shall be provided in sufficient quantities to execute testing in an expedient fashion.
- C. The test equipment shall be of industrial quality and suitable for testing and calibration with accuracy within the tolerance necessary to demonstrate system performance per the Contract Documents.
  - 1. Light meters shall have an accuracy of + or – 5.0 percent of the full scale and have been calibrated within the last year per NIST standards.
- D. The test equipment shall have calibration certification per equipment manufacturer's interval level or within one year if not otherwise specified. The calibration tags shall be affixed or certificates readily available for all test equipment.



### PART 3 - EXECUTION

#### 3.01 SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS

- A. All tests and start-up procedures shall be conducted without compromise to human or equipment safety. The General Contractor and Trade Sub- Contractors shall be responsible for the liability and safety of conducting all tests and startup.
- B. The General Contractor shall clearly identify and list any Deficiencies resulting from the Installation Verification, Start-up and Pre-Functional Checks & Tests on the associated forms and immediately notify the CxA. Once Deficiencies are corrected and verified or tested, update and resubmit the associated forms.
- C. The CxC and Trade Sub-Contractors shall a minimum 10 day's notice to the CxA for witnessing equipment Start-ups and Pre-Functional Checks & Tests.

#### 3.02 FUNCTIONAL PERFORMANCE TESTS

- A. Functional testing shall be performed and documented for 100% of all equipment in the scope of commissioning. At the discretion of the CxA and per the approved Cx Plan, the CxA may witness a percentage (sample) of the functional tests for selected, multiple identical pieces of non-life-safety or non-critical equipment.
- B. The General Contractor and Trade Sub-Contractors shall be responsible for the liability and safety of conducting all tests.
- C. Ensure the following are completed prior to the start of the FPTs:
  - 1. Certify through the System Readiness Checklist (SRC) forms that the HVAC systems, controls and instrumentation, equipment and assemblies have been installed, calibrated, started and are operating per the Contract Documents. Approval of the completed SRC forms by the CxA is required prior to conducting the FPTs.
  - 2. Where applicable, any graphics and programming for the sequence of operations and associated setpoints, schedules, and alarms shall be configured and the system operation checked and confirmed, prior to starting functional testing.
- D. Trade Sub-Contractors shall execute all FPTs per the approved test procedures on the FPT forms. All testing results shall be documented on the final FPT forms; the forms shall be signed and dated by the representative performing the tests. Off hours or weekend work may be required to complete the FPTs.
- E. The CxC and Trade Sub-Contractors shall coordinate all FPT with the CxA, and provide a minimum of 10 day's notice prior to conducting each system test.
- F. FPT for each system must be successfully completed and signed by the CxA prior to formal approval of system commissioning.
- G. FPT may be conducted using these approved test methods:
  - 1. Manually manipulating the equipment settings to observe performance.
  - 2. Overwriting control system sensor values to simulate a condition, such as overwriting a field sensor reading to be something other than it actually is.
  - 3. Altering setpoints to force equipment into a mode of operation to verify a sequence.
  - 4. Using indirect indicators, such as readings from a control system screen reporting a controllable device status, for testing responses will be allowed only after the actual conditions represented by the indirect indicators have been directly verified, calibrated and documented on the SRC forms (as a pre-functional check/test).
  - 5. Monitoring performance by analyzing the control system Trend data. The CxA will analyze the control system Trend data.

- H. Setup:
  - 1. The Trade Sub-Contractor executing the test shall document the pre-test normal condition on the test form.
  - 2. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible.
  - 3. The Trade Sub-Contractor executing the test shall provide all necessary materials, system modifications, overrides, etc. to produce the necessary conditions to execute the test according to the test procedures.
  - 4. At completion of the test, the Trade Sub-Contractor shall return all affected building equipment and systems to their pre-test normal condition.

### 3.03 COMMISSIONING ISSUES, BACK-CHECKS AND RE-TESTING

- A. All Deficiencies and Issues shall be documented on the appropriate forms in use, and will additionally be documented by the CxA on a Cx Issues List.
- B. Immediate correction of minor Deficiencies identified during testing may be allowed at the discretion of the CxA. In such cases the Deficiency and identified resolution must still be documented on the commissioning form in use.
- C. When Cx Issues are identified during FPT, the CxA will discuss with the executing Trade Sub-Contractor and/or CxC and determine whether testing can proceed or be suspended. The Commissioning Issue and any identified resolution will be documented on the test form in use in addition to the Commissioning Issues List.
- D. The CxA will maintain and update the Commissioning Issues List, and document the issues resolution process. Copies will be distributed to the General Contractor, Owner, and Trade Sub-Contractors as appropriate.
- E. All Deficiencies and Commissioning Issues shall be corrected promptly. The responsible party shall correct the issue and inform the CxC and CxA of the resolution and completion date. The CxA will record completion on the Commissioning Issues List once the issue is successfully back-checked or verified and the CxC shall reschedule testing with the CxA and Trade Sub-Contractor. Testing shall be repeated until passing performance is achieved or the Owner accepts the noted issue.
- F. When there is a dispute regarding a Cx Issue, whether it is valid or who is responsible, additional parties may be brought into the discussion as appropriate. The CxA will have the final interpretive authority on Cx Issues and Deficiencies and the Owner will have the final approval authority.
- G. The CxA may recommend solutions to Deficiencies and Commissioning Issues. However, the burden of responsibility to solve, correct and perform required retests is with the General Contractor, Trade Sub-Contractors, and the Design Professional(s).
- H. Additional Back-check Verifications and Re-testing:
  - 1. For all Commissioning Issues identified during the pre-functional system readiness activities, the CxA will back-check and verify the completion of the issues where appropriate.
  - 2. For all Commissioning Issues identified during FPT, retesting is required to verify the resolution of the issue and to complete the FPT.
  - 3. The CxA will witness one re-test for each equipment and will perform one back-check verification of any completed system readiness issue. The Owner may back-charge the General Contractor for any additional fees from the CxA, resulting from any re-testing or repeated system readiness issues list back-checks beyond the first re-test or back-check.

4. A minimum 48 hour's notice is required for scheduling any re-testing, though the CxA will attempt to accommodate a shorter timeframe if feasible.
  5. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension.
- I. For any re-testing required, the CxA will determine if the entire test must be re-tested or if it is acceptable to re-test specific portions of the test that had failed.

#### 3.04 DEFERRED & SEASONAL TESTING

- A. Before or during the end of the first year Warranty Period, any Seasonal or Deferred Testing as defined in the Cx Plan, shall be completed as part of this contract. Tests shall be conducted by the Trade Sub-Contractor responsible for the equipment and systems, completed in the same manner as all other commissioning tests, and shall be witnessed by the CxA.
- B. The General Contractor shall coordinate with CxA and Owner and schedule all Deferred and Seasonal Testing.
- C. The General Contractor shall make final adjustments to the as-built documentation or drawings for any modifications made during Deferred or Seasonal Testing.

#### 3.05 O&M MANUAL AND TRAINING VERIFICATION

- A. The General Contractor and the CxC shall coordinate and schedule the training for Owner Personnel. The CxC shall ensure that training is completed per the requirements of the construction documents and specifications.
- B. Trade Sub-Contractors responsible for specific equipment and system training shall submit to the CxC, a written training agenda for each training class for the equipment and systems to be commissioned, no less than 14 days prior to start of training. The General Contractor shall submit the training agendas to CxA and Owner for review and approval. The training agendas shall cover the following elements:
  1. Equipment and/or systems included in training
  2. Intended audience
  3. Location of training
  4. Subjects covered (including a brief description and duration, presentation methods, etc.)
  5. Instructor's name and qualifications
  6. Copy of any handout materials or presentations.
- C. The CxA will review the training plans to verify compliance with the specifications.
- D. The General Contractor shall submit to CxA 'attendee signed' attendance sheets for each training session conducted and a copy of the final training presentations.
- E. The CxA will verify with the Owner that the final O&M manuals have been delivered per the Contract Documents. The CxA will review the draft O&M manuals for content and completeness and will verify with the Owner that the final O&M manuals have been delivered per the Contract Documents.

#### 3.06 COMMISSIONING ACCEPTANCE, CLOSE-OUT AND REPORTING

- A. Completion of the main commissioning activities (system readiness checks, functional testing, training, and delivery of O&M manuals) shall be accomplished as a prerequisite for substantial completion. Completion of all commissioning issues and any re-testing shall be completed prior to final acceptance of commissioning.

- B. After completion of the commissioning activities and following review of the completed commissioning documents that includes the draft Cx Report executive summary, all test results and the latest Cx Issues List with all remaining commissioning issues and deficiencies, the Owner will provide a formal written acceptance of the project construction phase commissioning. At that point, any remaining construction phase commissioning issues or seasonal/deferred testing will be transferred to the warranty phase and tracked by the CxA as part of the LEED Post-Occupancy Warranty Phase Commissioning.
- C. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Final Commissioning Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all General Contractor and Trade Sub-Contractor commissioning documentation.
- D. The Owner's written acceptance of construction phase commissioning will be included in the Final Commissioning Report.
- E. The CxA will complete a LEED Systems Manual for the systems and equipment commissioned, with assistance provided by the CxC and Trade Sub-Contractors. The Systems Manual will provide the operating staff the information needed to understand and optimally operate the commissioned systems. Per LEED enhanced commissioning requirements, the Systems Manual will contain the following sections and detail:
  - 1. Final version of the BOD and systems narrative.
  - 2. Systems single line diagrams or schematics.
  - 3. Final as-built sequence of operations, control drawings (P&IDs), points lists and setpoints.
  - 4. Additional operating instructions for key systems or integrated building systems such as water-side and air-side HVAC systems and controls, lighting controls, etc.
  - 5. Recommended schedule of major maintenance requirements and frequency, if not already included in the project O&M Manuals.
    - a. A summary of the preventative maintenance and service procedures is recommended in the Systems Manual, for the major MEP equipment, including a schedule matrix checklist (checked as weekly, monthly, quarterly, annually, etc.).
    - b. Recommended schedule for retesting of commissioned systems with blank test forms from the Final Commissioning Plan.
    - c. Recommended schedule for calibrating sensors and actuators.

### 3.07 POST-OCCUPANCY WARRANTY PHASE COMMISSIONING

- A. Per the LEED Enhanced Commissioning requirements, no later than 90 days prior to the expiration of the first 12 month warranty period of building occupancy, the CxA will return to the facility to interview facility staff, walk the facility and review systems operation to identify any issues. Key representatives from the General Contractor and Trade Sub-Contractors shall also attend, as determined by the CxA.
- B. The CxA will also review BAS trend data during the Post-Occupancy Warranty Phase. The BAS Trade Contractor will be responsible for providing post-occupancy trend data to the CxA.
- C. Any performance issues, warranty items or problems identified will be reported by the CxA to the CxC via a Warranty Phase Commissioning Issues List for correction by the General Contractor and Trade Sub-Contractors prior to the end of the warranty period. The CxC shall work with the Trade Sub-Contractors and O&M staff to make corrections and modifications as required.

- D. After correcting noted Warranty Phase Cx Issues, the General Contractor shall notify the CxA in writing, and the CxA will back-check and verify that the Warranty Phase Cx Issue was resolved.
- E. Issues identified during the warranty period will remain Warranty Phase Cx Issues until satisfactory completion by General Contractor and back-check verification by CxA, even if the warranty period expires during the correction and back-check period.

END OF SECTION

## SECTION 26 09 23 – MODULAR DIMMING CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Central dimming control systems.
- B. Related Sections:
  - 1. Section 26 27 26 - Wiring Devices

#### 1.2 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
  - 1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- B. ASTM International (ASTM)
  - 1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
- C. Canadian Standards Association (CSA)
  - 1. CSA C22.2 # 14 Industrial Control Equipment
  - 2. CSA C22.2 # 184 Solid-State Lighting Controls
  - 3. CSA C22.2 # 156 Solid-State Speed Controls
- D. International Electro-technical Commission
  - 1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
  - 2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- E. International Organization for Standardization (ISO)
  - 1. 9001:2000 – Quality Management Systems.
- F. F. National Electrical Manufacturers Association (NEMA)
  - 1. WD1 (R2005) - General Color Requirements for Wiring Devices.
- G. G. Norma Oficial Mexicana (NOM)
  - 1. NOM-003-SCFI Productos eléctricos - Especificaciones de seguridad (Electrical products - Safety Specifications)
- H. H. Underwriters Laboratories, Inc. (UL):
  - 1. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - 2. 508 (1999) - Standard for Industrial Control Equipment.
  - 3. 1472 (1996) - Solid-State Dimming Controls.
  - 4. 924 (2003) - Emergency Lighting and Power Equipment.

#### 1.3 SYSTEM DESCRIPTION

- A. Modular dimming control: Factory assembled dimming control, interfaces, and modules. Low voltage wall stations, control interfaces, and sensors.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Specification Conformance Document: Indicate whether the submitted equipment:
  - 1. Meets specification exactly as stated.
  - 2. Meets specification via an alternate means and indicate the specific methodology used.
- C. Shop Drawings:
  - 1. Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
  - 2. Schematic of system.
- D. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Provide Operation and Maintenance Manuals:
  - 1. Including:
    - a. Warranty Information
    - b. System Start-up Information
    - c. Installation Guide
    - d. Set-up and Programming Guide
  - 2. Electronic format to be available on Lighting Control System manufacturer website.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.
- B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- C. Central dimming control system:
  - 1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

#### 1.7 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
  - 1. Ambient temperature: 0° to 40° C (32° to 104° F).
  - 2. Relative humidity: Maximum 90 percent, non-condensing.
  - 3. Lighting control system must be protected from dust during installation.

#### 1.8 WARRANTY

- A. Provide manufacturer's Enhanced 8 Year Limited Warranty:
  - 1. 8-year limited parts warranty for the replacement of defective lighting components from the date of system startup completion.
  - 2. 2-year Silver Level Support and Maintenance Plan that covers 100% parts and labor from the date of the system startup completion.
- B. Provide manufacturer's full 4 year warranty covering 100% parts and 100% labor from the date of system startup completion.

1. Silver Level Support and Maintenance Plan: includes 100% parts and labor coverage, 24/7 telephone technical support, and can be renewed annually.
2. Gold Level Support and Maintenance Plan: includes 100% parts and labor coverage, 24/7 telephone technical support, annual renewal option, 72-hour on-site response time, an annual scheduled maintenance visit and an upgrade of initial 2-year Silver Level Support and Maintenance Plan to Gold Level Support and Maintenance Plan.
3. Platinum Level Support and Maintenance Plan: includes 100% parts and labor coverage, 24/7 telephone technical support, annual renewal option, 24-hour on-site response time, an annual scheduled maintenance visit and an upgrade of initial 2-year Silver Level Support and Maintenance Plan to Platinum Level Support and Maintenance Plan.

#### 1.9 MAINTENANCE

- A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
- B. Make new replacement parts available for minimum of ten years from date of manufacture.
- C. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

#### 1.10 COMMISSIONING

- A. Support and Maintenance Plan - Gold Level
  1. Description – All Silver Benefits, Plus:
    - a. 72-hour response time – a Lutron services company representative will be on-site within 72 hours of the customer's call to assess the system and begin repairs.
    - b. Annual scheduled maintenance visit – a Lutron services company representative will visit the site once a year on a mutually agreed upon date between Lutron and the end-user. According to the site's requests and needs, the Lutron representative may complete the following tasks:
      - 1) Train facility staff on operation and maintenance of the system.
      - 2) Update staff on utilization of features and new capabilities.
      - 3) Make minor programming changes as requested.
      - 4) Perform a full system check and preventative maintenance to ensure that the system is working properly.
      - 5) Provide a system status report detailing the tasks accomplished on the visit date, important findings, and any recommendations to increase system efficiency and user satisfaction.
      - 6) Compile a list of spare parts to consider for site, upon request.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis of design product: Lutron GRAFIK Eye QS & Energi Savr Node or subject to compliance and prior approval with specified requirements of this section:
- B. Substitutions: Under provisions of Division 1.
  1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders.
  2. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
  3. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.



4. Provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

## 2.2 GENERAL

- A. Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
- B. Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.
- C. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
- D. Wireless Devices shall:
  1. Have addresses automatically assigned to them.
  2. Receive signals from other wireless devices and provide feedback to user.
  3. Work in conjunction with wireless occupancy sensors, wireless vacancy sensors, and wireless controllers.
  4. Use proprietary Radio Frequency (RF) protocol.
  5. Use RF communication in compliance with FCC Part 15.231.

## 2.3 DIMMING PERFORMANCE REQUIREMENTS

- A. Electrolytic capacitors to operate at least 20° C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.
- B. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): Manufacturer's maximum current rating minimum two times control's rated operating current.
- C. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer.
- D. Design and test dimmers to withstand line-side surges without impairment to performance.
  1. Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41.
  2. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.
- E. Utilize air gap off – activated when user selects “off” at any control to disconnect the load from line supply.
- F. Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption within 3 seconds.
- G. Multiple load type, tested to UL 508 to specifically control incandescent/tungsten, magnetic low voltage, electronic low voltage, neon/cold cathode, fluorescent dimming ballasts, and non-dim loads.
- H. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.
- I. Possess ability to have load types assigned per circuit, configured in field.
- J. Minimum and maximum light levels user adjustable on circuit-by-circuit basis.

- K. Control all light sources in smooth and continuous manor. Dimmers with visible steps are not acceptable.
- L. Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment to meet these requirements.
- M. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
- N. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
- O. Line Voltage Dimmers; Meet following load-specific requirements:
  - 1. Magnetic Low Voltage (MLV) transformer:
    - a. Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
    - b. Dimmers using back-to-back SCR construction that could fail open causing DC power to flow into magnetic low voltage load are not acceptable.
  - 2. Electronic Low Voltage (ELV) transformer: Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
  - 3. Neon and cold cathode transformers:
    - a. Magnetic transformers: UL listed for use with normal (low) power factor magnetic transformers. Electronic transformers: Must be supported by the ballast equipment manufacturer for control of specific ballasts being provided.
  - 4. Fluorescent electronic dimming ballast: Refer to Section [16580] for dimming ballast specifications and performance.
- P. Direct low-voltage control of digital ballasts (120V, 220/240V, and/or 277V lighting):
  - 1. Electronically link a digital fluorescent lighting ballast to a zone for both dimming and turn on/off.
  - 2. Energy usage and light level status visible to operator on an integral display.
  - 3. Electronically assign occupancy sensors for manual on/auto off and auto on/auto off.
  - 4. Electronically assign daylight sensors to digital ballasts and line voltage dimmers for proportional daylight harvesting.
  - 5. Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct (no-interface) control.
- Q. Low Voltage Dimming Interface; Meet following requirements:
  - 1. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
  - 2. Single low voltage dimming module; capable of controlling following light sources:
    - a. 0-10V analog voltage signal.
      - 1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
      - 2) Sink current via IEC 60929.

## 2.4 POWER INTERFACES

- A. Product: PHPM-PA-DV, PHPM-3F-DV, PHPM-SW-DV, NGRX-PB, GRX-FDBI, and/or GRX-TVI. Provide power interfaced required as defined on project drawings.

- B. Electrical:
  - 1. Phase independent of control input.
  - 2. Dimmer to meet limited short circuit test as defined in UL 20.
- C. Diagnostics and Service: Replacing power interface does not require re-programming of system or processor.

## 2.5 WALL STATIONS

- A. Line Voltage Wall Stations:
  - 1. Product: GRAFIK Eye QS
  - 2. Preset lighting control with zone override:
    - a. Intensity for each zone indicated by means of one illuminated bar graph per zone.
    - b. Each zone and scene to be field customizable to indicate each zone and scene name.
    - c. Astronomical time clock and programmer interface:
      - 1) Provide access to:
        - a) Scene selections.
        - b) Fade zone to a level.
        - c) Fine-tuning of preset levels with scene raise/lower.
        - d) Lock out scenes and zones.
        - e) Fine-tuning of light levels with individual zone raise/lower.
        - f) Terminal block for wired infrared signal input.
        - g) Enable/disable wall station.
    - d. Light intensity with real time energy savings by digital display.
    - e. Fade time indicated by digital display for current scene while fading.
    - f. Incorporate built-in wide angle infrared receiver.
    - g. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
  - 3. Preset shade control with zone override:
    - a. Preset expandable shade control: Provide up to 3 columns of shade control. See Section [12413 - Window Treatments:]
    - b. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
- B. Low Voltage Wall Stations:
  - 1. Product: see Touch QS.
  - 2. Electronics:
    - a. Use RS485 wiring for low voltage communication.
  - 3. Functionality:
    - a. Upon button press, LEDs to immediately illuminate.
    - b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or the LEDs turn off if the button press was not processed.
    - c. Allow for easy reprogramming without replacing unit.
    - d. Replacement of units does not require reprogramming.
  - 4. Provide faceplates with concealed mounting hardware.
- C. Color:
  - 1. Standard color to be selected.
  - 2. Color variation in same product family: Maximum  $\Delta E=1$ , CIE  $L^*a^*b$  color units.

3. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.
- D. Provide faceplates with concealed mounting hardware.
- E. Engrave wall stations with appropriate button, zone, and scene engraving descriptions furnished prior to fabrication.
- F. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

## 2.6 ENERGI SAVR NODE QS LIGHTING CONTROL MODULE

### A. Softswitch Lighting Control Module:

1. Product: QSN-4S16-S
2. Mechanical:
  - a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.
  - b. Delivered and installed as a UL listed factory assembled panel.
  - c. Panels passively cooled via free-convection, unaided by fans or other means.
3. Surface mounted
4. Switching:
  - a. Rated life of relay: Minimum 1,000,000 cycles.
  - b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
  - c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
  - d. Module to integrate up to 4 individually controlled zones, each with a capacity of up to 16 amps, of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, HID, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
5. Connection without interface to wired:
  - a. Occupancy sensors
  - b. Daylight sensors
  - c. IR receivers for personal control
6. Connects to Lighting Management Panel via RS485.
7. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
8. Thermal protection reports to Light Management System if module overheats.
9. Contact Closure Input
  - a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
    - 1) Activate scenes
    - 2) Enable or disable timeclock
10. Emergency Contact Closure Input
  - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
  - b. Allow configurable zone response during emergency state.
  - c. Disable control operation until emergency signal is cleared.

### B. 0-10V Lighting Control Module:

1. Product: QSN-4T16-S

2. Meet the following requirements:
    - a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
    - b. Single low voltage dimming module; capable of controlling following light sources:
      - 1) 0-10V analog voltage signal.
        - a) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
        - b) Sink current via IEC 60929.
  3. Mechanical:
    - a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.
    - b. Delivered and installed as a UL listed factory assembled panel.
    - c. Panels passively cooled via free-convection, unaided by fans or other means.
  4. Surface mounted
  5. Switching:
    - a. Rated life of relay: Minimum 1,000,000 cycles.
    - b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
    - c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
    - d. Module to integrate up to 4 individually controlled zones, each with a capacity of up to 16 amps, of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, HID, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
  6. Connection without interface to wired:
    - a. Occupancy sensors
    - b. Daylight sensors
    - c. IR receivers for personal control
  7. Connects to Lighting Management Panel via RS485.
  8. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
  9. Thermal protection reports to Light Management System if module overheats.
  10. Contact Closure Input
    - a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
      - 1) Activate scenes
      - 2) Enable or disable timeclock
  11. Emergency Contact Closure Input
    - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
    - b. Allow configurable zone response during emergency state.
    - c. Disable control operation until emergency signal is cleared.
- C. EcoSystem Digital Fixture Lighting Control Module
1. Product: QSN-2ECO-PS120
  2. Mechanical:
    - a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.

- b. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
- c. Panels passively cooled via free-convection, unaided by fans or other means.
- 3. Supports one or two independent links of up to 64 ballasts per link.
- 4. Connect without interface to wired:
  - a. Occupancy sensors
  - b. Daylight sensors
  - c. IR receivers for personal control
- 5. Connects to Lighting Management Panel via RS485.
- 6. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
- 7. Thermal protection reports to Light Management System if module overheats.
- 8. Contact Closure Input
  - a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
    - 1) Activate afterhours mode
    - 2) Provide basic load shed functionality
- 9. Emergency Contact Closure Input
  - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
  - b. Disable control operation until emergency signal is cleared.
- 10. Programming Connection:
  - a. Provide Ethernet input for wired connection to wireless router.
  - b. Provide ability for programming from an iPod touch or iPhone via wireless router.

## 2.7 LOW VOLTAGE CONTROL INTERFACES

- A. Contact Closure Interface:
  - 1. Product: QSE-IO
  - 2. The contact closure input device will accept both momentary and maintained contact closures.
  - 3. The contact closure output device can be configured for maintained or pulsed outputs.
- B. Contact Closure Input Interface:
  - 1. Product: QS seeTouch keypads Model QSWS2
  - 2. The contact closure input device will accept both momentary and maintained contact closures.
- C. Ethernet Interfaces; Lutron Model QSE-CI-NWK-E:
  - 1. Provide ability to communicate by means of:
    - a. TCP/IP over Ethernet to GRAFIK Eye QS system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
    - b. RS232 serial communication to GRAFIK Eye QS series system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 50 feet (15 meters) of RS232 source.
  - 2. Provide access to:
    - a. Scene selections.
    - b. Fade zone to a level.
    - c. Set level of shade(s).

- d. Fine-tuning of preset levels with scene raise/lower.
  - e. Lock out scenes and zones.
  - f. Fine-tuning of light levels with individual zone raise/lower.
  - g. Fine-tuning of shade levels with individual zone raise/lower.
  - h. Enable/disable wall station.
3. Provide status monitoring through button feedback and scene-status updates.

## 2.8 SENSORS

### A. Wireless Ceiling Occupancy/Vacancy Sensors

- 1. Product: LRF2-OCRB-P-WH/LRF2-VCRB-P-WH
- 2. Wireless Ceiling Sensors shall:
  - a. Have an operational lifetime of 10 years without the need to replace batteries when installed per manufacturer's instructions.
  - b. Communicate directly to compatible RF receiving devices through use of a radio frequency communications link.
  - c. Not require external power packs, power wiring, or communication wiring.
  - d. Provide a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
  - e. Have a multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
  - f. Utilize Infrared as its sensing mechanism coupled with Lutron XCT□ Technology for sensing fine motions. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
  - g. Have optional, readily accessible, user adjustable controls for timeout, automatic/manual-on, and sensitivity.
  - h. Have the ability to be placed in test mode to verify correct coverage and operation from the face of the unit.
  - i. Have a radio frequency range of up to 60' (18.3 m) between sensor and compatible RF receiving device(s).
  - j. Turn off lighting automatically after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area.
  - k. Comply with the limits for a Class B device, pursuant to part 15 of the FCC rules.
  - l. Communicate with up to 10 compatible RF receiving devices.
- 3. Mounting:
  - a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, compressed fiber ceilings.
  - b. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
  - c. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method shall be designed for easy, damage-free removal.
  - d. Ceiling-mount wireless occupancy/vacancy sensors using passive infrared technology shall have a customizable mask to block off unwanted viewing areas.
  - e. Sensor lens shall illuminate during test mode when motion is detected to allow installer to verify coverage prior to permanent mounting.
- 4. Wireless occupancy/vacancy sensor can be programmed to operate as an occupancy sensor (automatic-on and automatic-off functionality), an occupancy sensor with low light feature (automatic-on when less than 1 fc (10 lux) of ambient light available and automatic-off functionality), or a vacancy sensor (manual-on and automatic-off functionality).

5. A vacancy-only model shall be available to meet California Title 24 Energy Efficiency Standard requirements.
- B. Wired Ceiling and Wall Mount Occupancy/Vacancy Sensors
1. Product: LOS-CUS-500-WH/LOS-CUS-1000-WH/LOS-CUS-2000-WH/LOS-CIR-450-WH/LOS-CIR-1500-WH/LOS-CDT-500-WH/LOS-CDT-500R-WH/LOS-CDT-1000-WH/LOS-CDT-1000R-WH/LOS-CDT-2000-WH/LOS-CDT-2000R-WH/LOS-WIR-WH/LOS-WDT-WH/LOS-WDT-R-WH.
  2. Sensing mechanism:
    - a. Dual technology:
      - 1) Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
      - 2) Utilize an operating frequency of 32kHz or 40kHz that shall be crystal controlled to operate within plus or minus 0.005 percent tolerance.
  3. Connect directly to EcoSystem ballast and modules without the need of a power pack or other interface
  4. Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space
  5. Sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.
  6. Sensors shall be UL listed (as appropriate)
  7. Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space
  8. Sensors shall have field adjustable controls for time delay and sensitivity to override any adaptive features.
  9. Power failure memory:
    - a. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
  10. Provide all necessary mounting hardware and instructions.
  11. Sensors shall be Class 2 devices.
  12. Indicate viewing directions on mounting bracket for all Ceiling mount sensors.
  13. Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
  14. Provide swivel mount base for all wall mount sensors.
- C. Sensor Power Packs
1. Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
  2. For ease of mounting, installation and future service, power pack(s) shall be able to mount through a 1/2" knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of three (3) sensors.
  3. Power pack shall be plenum rated
- D. Infrared Receivers
1. Product: EC-IR-WH
  2. Use Class 2 wiring for low voltage communication
  3. Can be replaced without reprogramming
  4. 360 degree reception of wireless infrared remote controls
  5. Immediate local LED response upon reception of hand held transmitter communication



6. Constructed with plastic meeting UL94 HB
7. Mountable on lighting fixtures or recessed acoustical ceiling tiles
8. Constructed via sonic welding
9. Color:
  - a. Match NEMA WD1, Section 2 White
  - b. Color variation in same product family: Maximum  $\Delta E=1$ , CIE L\*a\*b color units
  - c. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

E. Interior Daylight Sensors

1. Wireless Daylight Sensor:
  - a. Product: LRF2-DCRB-WH
    - 1) Open-loop basis for daylight sensor control scheme
    - 2) Stable output over temperature from 0 degrees to 40 degrees C
    - 3) Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection
    - 4) Provide linear response from 0 to 10,000 foot-candles
  - b. Wireless Daylight Sensors shall:
    - 1) Have an operational lifetime of 10 years without the need to replace batteries when installed per manufacturer's instructions.
    - 2) Communicate directly to compatible RF receiving devices through use of a radio frequency communications link.
    - 3) Not require external power packs, power wiring, or communication wiring.
    - 4) Have the ability to be placed in test mode to verify correct operation from the face of the unit.
    - 5) Have a radio frequency range of up to 18.3 meters (60 feet) between sensor and compatible RF receiving device(s).
    - 6) Comply with the limits for a Class B device, pursuant to part 15 of the FCC rules.
    - 7) Color:
      - a) Match NEMA WD1, Section 2 White
  - c. Mounting:
    - 1) Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, compressed fiber ceilings.
    - 2) Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
    - 3) Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method shall be designed for easy, damage-free removal.
  - d. Shall meet California Title 24 Energy Efficiency Standard requirements.

F. Exterior Daylight Sensors

1. Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
2. Enclosed in weatherproof housing with shading and lens protection visor.

2.9 ACCESSORIES

A. Emergency Lighting Interface; Lutron LUT-ELI

1. Provides total system listing to UL924 when used with Lutron GRAFIK Eye QS system.
2. Senses all three phases of building power.

3. Provides an output to power panels if power on any phase fails.
4. Accepts a contact closure input from a fire alarm control panel.

B. Tamper Proof Covers:

1. Locking covers for preset control units and wall stations: Reversible to allow lock to be located on either side of control.
2. Compatible with IR controls.
3. Does not reduce specified IR range by more than 50 percent of its original specification.

C. Infrared Transmitters:

1. Provide wireless remote control capable of recalling preset light level scenes plus “off” and of fine-tuning light levels with master raise/lower.
2. Provide wireless remote control capable of recalling preset shade levels for three presets plus “open” and “close” with fine-tuning shade levels with master raise/lower.
3. Designed for use in conjunction with compatible infrared receiver and lighting control; dependent on that receiver, not transmitter.
4. Operate up to 50 feet (15 meters) within line-of-sight to that receiver.
5. “Learnable” by other variable frequency remote controls.

2.10 SOURCE QUALITY CONTROL

- A. Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer’s installation instructions.
- B. Provide complete installation of system in accordance with Contract Documents.
- C. Define each dimmer's load type, shade settings, and set control functions.
- D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- E. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

3.2 STARTUP AND PROGRAMMING

- A. Provide factory-certified field service engineer to a site visit(s) to ensure proper system installation and operation under following parameters:
1. Qualifications for factory-certified field service engineer:
    - a. Minimum experience of 2 years training in the electrical/electronic field.
    - b. Certified by the equipment manufacturer on the system installed.
  2. Make site visits upon completion of installation of modular dimming control system:
    - a. Verify connection of power feeds and load circuits.
    - b. Verify connection and location of controls.
    - c. Program system data.
    - d. Verify proper connection of digital control link.
    - e. Verify proper operation of manufacturers interfacing equipment.
    - f. Obtain sign-off on system functions.
    - g. User to be trained on system operation.

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END OF SECTION

SECTION 26 09 37 – PHOTOVOLTAIC SYSTEM

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 GENERAL REQUIREMENTS

- A. Work included in this section: All design, materials, labor, equipment, services, and incidentals necessary to install a complete Photovoltaic (PV) System as shown in the contract documents and as specified to form a complete installation, ready for operation to produce solar power at the site, including but not limited to the work listed below.
- B. The contract documents shall be used as the performance criteria for the design and installation of a complete operational PV system. The Contractor shall include in their bid all additional design and engineering costs associated with the PV system design to be submitted, operation, Installation, and testing.
- C. The Contractor shall submit for and pay for the required permits and inspections with the local AHJ and utility company. The Contractor shall include any fees as part of the bid.
- D. The Contractor shall complete all of the required paper work for the utility interconnection agreement contract in conjunction with the Engineer's input and approval, including rate schedule designations. In order for the Installer to act on behalf of the Engineer, The Contractor (in conjunction with the Engineer) shall submit to the utility company the proper authorization forms.
- E. The Contractor shall be responsible for and submitting, filing fees, and obtains any relevant buy-down incentive rebates available for the system and properly credit the value to the Engineer. This shall include application (and payment) of all required "reservation" applications as well as system applications and system certification and testing with the utility company to receive the final rebates. The Contractor shall include application fees as part of the bid.
- F. The Contractor shall be responsible for adequate clearance and equipment space within each allotted areas. Alternate equipment sizes or requirements due to alternate designs are the responsibility of the contractor. Additional floor area within the buildings will not be made available for PV system equipment beyond that shown in these documents. The submitted design must work-within these limits.
- G. The system shall comply with the contract documents, all codes, and local authorities. The equipment includes, but is not limited to, PV modules, inverters, disconnects, wire, conduit, junction boxes, mounting hardware, and monitoring equipment.
- H. The Contractor shall furnish and/or pay for all materials, fees, permits, not covered in the general building permit, labor, tools, equipment, transportation and services required for a complete installation. The Contractor shall include all the relevant fees as part of the bid.
- I. Contractor shall provide access to equipment for maintenance and service as required by the manufacturer's instructions and/or applicable codes.
- J. The Contractor shall coordinate with the Architect on the locations and appearance of all exposed equipment, including but not limited to, PV modules, conduit, inverter[s], wireways, and control and monitoring equipment. All locations must be approved by the Architect.
- K. The Contractor shall visit the site to ascertain the nature and location of the work and the general and local conditions that could affect the work or the cost thereof.

- L. Given that the PV system installation requires work to be performed by various sub-contractors, the Contractor shall provide coordination with all trades needed for a complete installation including all required electrical services, building integration elements, monitoring equipment, and clearances.
- M. The Contractor shall comply with all requirements of Division 260000 and with the conditions of the Contract. The Contractor shall comply with the general conditions of this specification for requirements for submittals, substitutions, testing, training, warranty, damage responsibility, permits, fees, clean-up, and all other general items, in addition to any specific requirements of this section. The Contractor shall include fees as part of the bid.
- N. Work shall comply with all applicable codes, standards, local authorities, utilities and manufacturer's instructions/recommendations.
- O. All work shall comply with the Building Department, Health Department, Fire Department, and all other local authorities having jurisdiction.
- P. All work, including equipment, materials, and installation shall conform to California Administrative Code, Title 24, and Building Standards (CAC Title 24); to California Administrative Code, Title 8, Chapter 4, Division of Industrial Safety (DIS); National Electric Code; and Uniform Fire Code, editions under jurisdiction.
- Q. The minimum requirement of the more stringent code or standard shall govern where more than one code or standard is applicable to any component or condition.
- R. The Contractor shall immediately notify the Architect of any provision in the specifications that is contrary to the applicable codes.
- S. Any work performed by the Contractor at variance with the applicable codes and without prior written approval of the Architect shall be corrected as required without additional cost to the Engineer.

### 1.3 SYSTEM REQUIREMENTS

- A. The Contractor shall provide, install, commission, and test a new minimum 7.0 kW (DC) grid-tied photovoltaic (PV) system. The photovoltaic panels shall be installed in the roof of the building and within the designed areas as shown on the plans. The photovoltaic panels shall generate a minimum 10W/sf (DC) electrical power. The photovoltaic system power rating shall meet CEC-AC ratings.
- B. The contractor shall note that the photovoltaic panel layouts is based in Sanyo HIT Double 195 Bifacial Photovoltaic Module. If different type of system is proposed, the contractor shall ensure that the proposed system shall meet the same performance and sizes.
- C. Refer to the contract documents for the building roof areas to be provided with PV panels to form the complete system. Refer to the Architectural and Structural drawings for all roof types and details. Include any required structural or architectural engineering calculations in the bid amount, related to the PV system installation or roof penetrations.
- D. The system shall be utility grid connected with no storage batteries. The contractor shall be responsible for all required local utility coordination, approval, and applications for the complete interconnection of the PV system with the local utility grid, including bi-directional utility meter.
- E. The system shall consist of multiple arrays of framed photovoltaic modules, all mounting hardware, terminal boxes and combiner panels, quick-connect electrical collectors, DC wiring, DC disconnects, utility interactive inverters, AC disconnects, isolation transformers, all related AC feeders, main PV distribution panel, main PV system disconnect, and a complete data acquisition and monitoring system to allow the Engineer to monitor and utilize the collected data.

- F. The arrays shall cover various roof areas as indicated on the contract documents. The system as a whole shall produce a minimum peak (KW) of 7.0 kW DC using the roof areas shown. Higher values are allowed but the roof areas and loading factors shown on the contract documents shall not be exceeded.
  - G. The photovoltaic contract documents show available equipment locations for the PV system. The Contractor must obtain approval before altering any of the criteria set forth in these documents.
  - H. All DC conductors shall be sized such that there is a maximum of 2% voltage drop measured at the short circuit current rating of that circuit over the entire length of each circuit from PV module to inverter and back to PV module. All AC conductors shall be sized for a maximum of 2% voltage drop measured at the continuous AC current rating of the inverter between the inverter and the point of interconnection with the grid.
  - I. Each series string of PV modules shall be independently protected by an isolation fuse or breaker before it is connected in parallel with the other string on that PV output circuit. The current rating of this isolation fuse or breaker shall be less than the de-rated ampacity of the wiring that it is protecting and greater than 1.56 times the short circuit current rating of the PV modules in that PV source circuit. All other conductors and overcurrent devices shall be sized per the requirements of National Electric Code (NEC) Article 690-8.
  - J. The Contractor shall note that photovoltaic system shall be designed at 480VY/277V, 3 phase, and 4 wires for interfacing to the building's electrical system.
- 1.4 APPLICABLE GUIDELINES / REGULATIONS / STANDARDS
- A. National Electric Code (NEC)
    - 1. Article 690 – Solar Photovoltaic Systems.
    - 2. Article 250 - Grounding.
    - 3. Article 110 – Requirements for Electrical Installations.
  - B. IEEE Standards
    - 1. 1. IEEE 1262 (1995) – PV Module Qualification for Performance and Reliability.
    - 2. 2. IEEE 929 (2000) – Inverter Interconnection Standard.
  - C. Underwriter's Laboratories (UL) Standards
    - 1. UL1703 – Flat Plate PV Modules and Panels.
    - 2. UL1741 – Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems.
  - D. National Fire Protection Association Standards
  - E. CPUC approved Electric Rule 21 – Generating Facility Interconnections
  - F. OSHA Standards 1926 Subpart M – Fall Protection
- 1.5 UTILITY APPROVAL
- A. Once the Contractor has all required building and electrical permits, Contractor shall file all required paperwork and forms with Southern California Edison (SCE) to apply for interconnection with the utility grid.
  - B. Upon receipt of final building inspection approval, Contractor shall immediately send a copy of the signed-off building permit to Southern California Edison (SCE) and schedule the final SCE inspection for the system. This inspection shall be scheduled for a date no later than two weeks after the date of final building inspection.

1.6 INCENTIVE PROGRAMS

- A. Upon receipt of signed contract for this job, Contractor shall immediately file all forms required for any applicable rebate incentive reservations.
- B. The Contractor shall be responsible for completing the PV system installation as required, by the rebate deadline. The Contractor is responsible for applying for any needed time extensions and for securing the extensions. If this project is disqualified from the rebate due to the Contractor's failure to meet the deadline or secure an extension, the Contractor shall reimburse the Engineer for the full rebate amount.
- C. Upon receipt of signed contract for this job the contractor will be informed of any deadlines associated with utility rebates which the Engineer had applied.
- D. The contractor shall be responsible for completing the PV system installation as required, by the rebate deadline. The Contractor is responsible for paying for any needed time extensions. If this project is disqualified from the rebate due to the Contractor's failure to meet the deadline, the Contractor shall reimburse the Engineer for the full rebate amount
- E. Upon receipt of final building inspection approval, Contractor shall immediately file all forms and paperwork required to claim the reserved rebate payment.

1.7 QUALITY ASSURANCE

- A. Contractor Qualifications: The PV system as described herein shall be built by a licensed (C-46) solar contractor and a licensed (C-10) electrical contractor approved by the PV manufacturer to install the PV system.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 350 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Acceptable system manufacturers/vendors shall have been in the business of producing and/or installing similar commercial grade solar photovoltaic systems for the last 5 years minimum (7.0KW systems or higher). Manufacturers shall provide their latest line of equipment, meeting all current industry standards
- D. Source Limitations: All PV Panels shall be from a single manufacturer unless otherwise noted.
- E. Photovoltaic modules shall be tested in the factory for design performance and results shall be included in the Operation and Maintenance manuals.
- F. Inverters shall be factory tested for performance and results shall be included in the O & M manuals.
- G. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. All equipment and panels shall be handled with care so as not to damage the delivered products. All equipment shall be installed in new and neat condition.

1.9 WARRANTY

- A. The Contractor shall warrant that the work conforms to Contract requirements and is free of any defects.

- B. The Contractor shall provide a minimum of a full five-year warranty against breakdown or degradation of electrical output. The warranty must cover all of the components of the PV generating system against breakdown or degradation in electrical output of more than 10% of their originally rated electrical output. The warranty shall cover the full parts and labor cost of repair or replacement of defective components or systems for a period of five years from the date of acceptance by the Engineer.
- C. The photovoltaic panels shall be covered by a manufacturer warranty for a minimum of 20 years.
- D. The inverters shall be covered by a manufacturer warranty for a minimum of 10 years
- E. Any defective materials or inferior workmanship during installation and/or the warranty period shall be corrected immediately to the entire satisfaction of the Architect and without additional cost to the Engineer.

#### 1.10 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories
  - 1. DC/AC Inverters.
  - 2. DC combiner boxes with fusing.
  - 3. KWH Meter and Logger
  - 4. Data Acquisition System
  - 5. PV System weights
  - 6. PV cells / tiles
  - 7. Installation Manuals
- B. Shop Drawings:
  - 1. Wiring diagrams to detail power, signal, control, and correction circuits. Identify terminals and wiring color-codes to facilitate installation, operation, and maintenance. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring.
  - 2. Roof plans with the PV System layout (based on submitted panel)
  - 3. Details of seismic restraints including mounting, anchoring, and fastening devices.
  - 4. Dimensioned Outline Drawings of Mounting Rack for Photovoltaic Panels: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.
- C. Manufacturer Seismic Qualification Certification: Submit certification that Photovoltaic system components and their mounting and anchorage provisions are designed to remain in place without separation of any parts when subjected to the seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
  - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
  - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For Installer and manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Manuals



## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials, fixtures, and equipment required for the work shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Architect shall be furnished.
- B. All equipment shall be listed and labeled per recognized electrical testing laboratory and installed per the listing requirements and the manufacturer's instructions.

### 2.2 PHOTOVOLTAIC PANELS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Sanyo
  - 2. Sharp
  - 3. BP Solar
  - 4. Kyocera
- B. Provide equipment as specified or equipment of equal quality and performance. Provide all accessories needed for a complete, secure, operational grid-tied PV system.
- C. PV modules shall be IEEE 1262 compliant and listed to UL Standard 1703.
- D. The PV modules shall have the following physical properties as a minimum.
  - 1. Module Dimensions: 53.2" x 35.4" x 2.4" max.
  - 2. Installed Wind Uplift Resistance: 140 mph Per ASCE 7.95.
  - 3. Corrosive Atmosphere resistance (Salt Spray): UL 1703.
  - 4. Impact Resistance: Safely withstand 2" diameter steel sphere dropped 51 inches, UL 1703.
  - 5. Mechanical Loading: 45 lb/ft<sup>2</sup> 30 minutes, UL 1703.
  - 6. Humidity: -40 Deg. C to 85 Deg. C, 85%RH 10 cycles, UL1703.
- E. The PV modules shall have the following electrical characteristics as a minimum standard at Standard Test Conditions (STC).
  - 1. Rated Power Output (Pr): 195 Watts
  - 2. Open Circuit Voltage (Voc): 68.7 Volts.
  - 3. Module Efficiency: 16.1%
  - 4. Maximum Power Voltage (Vmp): 55.8 Volts.
  - 5. Maximum System Voltage (Vsys): 600 Volts
  - 6. Short Circuit Current (Isc): 3.73 Amps
  - 7. Maximum Power Current (Imp): 3.5 Amps

### 2.3 DC/AC INVERTER

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. SatCon
  - 2. Xantrex
  - 3. PV Powered
  - 4. Solectria

- B. All inverters shall be CEC approved and shall be utility interactive type.
  - C. The inverter[s] shall have the following physical properties as a minimum.
    - 1. Nominal AC Voltage: 208 VAC, 3-phase, 60 Hz.
    - 2. AC Current Distortion (At rated power) <5% THD
    - 3. Maximum Open Circuit Voltage 600 VDC.
    - 4. Power Tracking Window Range 330 to 600 VDC.
    - 5. Maximum Ripple Current (% of rated current) <5%.
    - 6. Peak Inverter Efficiency >95%.
    - 7. Standby Tare Losses <30 watts.
    - 8. Temperature Range Ambient -40 F to 122 Deg. F (-200 Deg. C to 500 Deg. C).
    - 9. Enclosure Environmental Rating NEMA 3R.
    - 10. Relative Humidity (non-condensing) 0-95%.
    - 11. Array Configuration: Monopole, negative grounded or floating -Bi-polar, neutral grounded.
    - 12. Cooling Method: Forced convection cooling.
    - 13. Protective Functions:
      - a. Standard wakeup voltage.
      - b. Wakeup time delay.
      - c. Shut down power.
      - d. Shut down time delay.
      - e. AC over / under voltage and time delays.
      - f. AC over / under frequency and time delays.
      - g. Ground over current.
      - h. Over-temperature.
      - i. AC and DC over current.
      - j. DC over voltage.
    - 14. User Display: Standard-LCD, four-line, twenty characters, with i. on/off toggle switch.
    - 15. AC Disconnect: NEMA 3R wall mount enclosure, load break rated.
    - 16. DC Disconnect: NEMA 3R wall mount enclosure, 600 VDC load break rated.
    - 17. Isolation Transformer: High efficiency, floor mount enclosure.
    - 18. Combiner Enclosures: Pole with diodes, NEMA 3R mounted enclosure.
    - 19. Communications Software: Serial communications and control software
  - D. All inverters shall be IEEE 929 compliant, listed to UL Standard 1741, and inspected by SCE before commissioning, testing, and operation of the system.
  - E. The inverters shall automatically drop-off-line when normal utility power is lost to avoid unintentional islanding effects. Drop-off to be activated by over-voltage (110%) and under-voltage (88%), and shall be adjustable. Frequency drifts outside 59.3 to 60.5 Hz for more than 10 cycles shall also activate automatic drop-off. Automatic reconnection shall not occur until the normal utility power has been stable for at least 60 seconds.
  - F. All electrical system equipment shall be properly rated to withstand and interrupt (in the case of over current protection devices) the available fault current at the point of use.
  - G. The system shall be capable of operating between a power factor of 0.9 lagging to 0.9 leading.
  - H. All required overcurrent protection and electrical bussing sizes per NEC 690.
- 2.4 ARRAY MOUNTING
- A. Modules shall be roof mounted within roof depressed cells, parallel to the roof surface, with appropriate racking hardware and structural attachments to the structural stanchions.

## 2.5 MONITORING

- A. A Data Acquisition and Monitoring System (DAS) shall be provided as part of the System. The system shall allow measurement, calculation, and display of:
  - 1. Ambient temperature.
  - 2. Wind speed.
  - 3. Solar irradiation.
  - 4. System electrical functions (instantaneous and accumulated power output (KW and KWH), AC and DC system voltage and amperage, and peak value tracking with associated time stamps).
  - 5. Pounds of CO2 emissions avoided from the generation of PV energy at the site.
- B. The DAS shall include a data logger, modem for data retrieval, and all parts and sensors to accurately measure the above specified data points.

## 2.6 WIRE AND CABLE

- A. Conductors: Insulated copper, with minimum sizes as recommended by the connected device manufacturer.
- B. 600-V ac and Class 1 Signal and Control Circuits: Stranded single conductors in raceway of size recommended by system manufacturer. Materials and installation requirements are specified in the electrical specification
- C. Classes 2 and 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable.
- D. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.
- E. Plenum Cable: Listed and labeled for use in air-handling spaces, plenums, and plenum ceilings.
- F. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Photovoltaic system shall be interconnected with the utility grid per the requirements of NEC Art. 690-64 (b), Load Side Connection.
- B. Mount system components with fastening methods and devices designed to resist the seismic forces.
- C. All equipment shall be properly grounded per the requirements of the National Electric Code, Article 250.
- D. Wiring: Install 60-Hz wiring according to NFPA 70. Install data cable complying with TIA/EIA-568-A. Install number of conductors recommended by system manufacturer for functions indicated, and as follows:
  - 1. Conceal wiring except in unfinished spaces.
  - 2. Wiring Method: Install wiring in raceways.
  - 3. Wiring Method: Install wiring in raceways except for Classes 2 and 3 remote-controls and signaling circuits, as defined in NFPA 70, if installed in accessible ceiling spaces and hollow gypsum-board partitions, where unenclosed wiring method may be used. Install listed plenum cable for Classes 2 and 3 wiring in environmental air spaces, including plenum ceilings.

4. Wiring Method: Install metal-clad cable except for Classes 2 and 3 remote-controls and signaling circuits, as defined in NFPA 70, if installed in accessible ceiling spaces and hollow gypsum-board partitions, where unenclosed wiring method may be used. Install listed plenum cable for Classes 2 and 3 wiring in environmental air spaces, including plenum ceilings.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess.
- F. System Installation shall conform to Manufacturers Installation Manual and approved project drawings and specifications.
- G. All PV modules to be installed such that they are 100% free from shade between 8am and 5pm daily.
- H. Structural members for PV supports should be aluminum.
- I. Heavy duty urethane sealants shall be used for all non-flashed roof penetrations.
- J. No dissimilar metals allowed to contact (use plastic or rubber washers).
- K. No aluminum in contact with concrete or masonry materials.
- L. Use high quality stainless steel fasteners only.
- M. An inverter backfeed disconnect shall be provided in a location that is less than 10 feet from the electrical meter. Opening of this disconnect shall prevent all solar power sources on site from backfeeding the grid.
- N. All exterior equipment to be sunlight and UV resistant as well as rated for elevated temperatures at which they are expected to operate (on roofs in hot sunlight).
- O. Photovoltaic modules shall be interconnected using cable assemblies. The pigtails shall be quick- connect electrical wiring connections rated for the application. The cables shall be running in conduit sleeves as shown in the roof plans.
- P. All circuits connected to more than one source shall have overcurrent devices located so as to provide overcurrent protection from all sources per NEC Article 690-9 (a).
- Q. Each array may have at least one terminal box, providing a watertight entry to the conduit leading to the combiner box. The terminal box and combiner box can be one physical unit
- R. Each set of building arrays shall have a DC combiner box, containing fuses and a bus to combine the outputs of the strings.
- S. Shoring: The Contractor shall provide all permanent and temporary shoring, anchoring and bracing required by the nature of this work in order to make all parts absolutely stable and rigid, even when such shoring, anchoring and bracing are not explicitly called for.
- T. Support all work adequately and per code. All equipment shall be securely attached to the building structure in an approved manner.
- U. Cut no structural members. If equipment cannot be properly concealed, notify Architect. Any patching and cutting done as a result of error or neglect on the part of the Contractor shall be done at the expense of the Contractor.
- V. Contractor shall keep work areas in a clean and safe condition. Remove all equipment, tools, vehicles, rubbish, waste and debris from the site upon completion of the job. The Contractor shall pay all fees for recycling and disposal.

### 3.2 UTILITY INTERCONNECTION

- A. The PV generation system shall not be interconnected with the Utility's distribution facilities until written authorization from the Utility Company has been obtained. Unauthorized inter-connections may result in injury to persons and damage to equipment or property for which the installing contractor will be liable.

### 3.3 ELECTRICAL CONNECTIONS

- A. Make splices, taps, and terminations on numbered terminal strips in junction, pull and outlet boxes, terminal cabinets, and equipment enclosures.

### 3.4 IDENTIFICATION

- A. Color-code wire and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.
- B. Provide labels per NEC Article 690-17 and Article 690-53. The PV backfeed sub-panel and all breakers contained in it and the PV system disconnect shall be clearly labeled.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engineer will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in programming and field testing. Report results in writing.
- C. The Contractor shall notify the Architect a minimum of 5 days before closing in of to-be-concealed work so that an Engineer's representative may inspect the work.
- D. Testing to be performed per CPUC Electric Rule 21 testing procedures and requirements.
- E. All testing to be done on "no-cloud" days to avoid system fluctuation by passing clouds.
- F. Perform the following field adjustments, tests, inspections, Commissioning, and prepare test reports:
  - 1. Before starting or operating the system Contractor shall check continuity of all conductors and grounding conductors to verify that there are no faults and that all equipment has been properly installed. Check factory instructions to see that installations have been made accordingly. Check equipment for any damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment or replace with new equipment of like kind.
  - 2. Before starting or operating the system Contractor shall obtain a final inspection approval from the Building Department and a final inspection approval from SCE. Contractor shall be present on site for both of these inspections.
  - 3. Once Building Department and SCE final approvals have been received, Contractor shall test all equipment to ensure specified capacity and performance of the system. The Contractor shall notify the Architect a minimum of 5 days prior to the test so that an Engineer's representative may witness the test.
  - 4. PV Module Test: During the daytime while the sun is shining on the PV array, measure the output current of each sub-array.
  - 5. Perform startup checks for all equipment per manufacturer's written instructions.

6. Contractor shall make final adjustments to all inverters and monitoring equipment in accordance with the specified system operation and the manufacturer's recommendations so that they will be placed in an acceptable operating condition. Adjustable parameters shall be set so that the PV system will produce the maximum possible amount of energy on an annual basis
  7. Verify that controls are properly labeled and interconnecting wires and terminals are identified.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Test Reports to be included in O&M Manual: Prepare a written report to record the following:
1. Output current readings from PV Module Test.
- 3.6 DEMONSTRATION
- A. Provide a complete walk-through and training service for the PV system
1. Train Engineers' maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
  2. Schedule training with Contracting Officer with at least seven days' advance notice
- B. Engage a factory-authorized service representative to train Engineer's maintenance personnel to adjust, operate, and maintain Photovoltaic system components. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION

## SECTION 26 24 13 – SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide distribution switchboards as required.

#### 1.2 SUBMITTALS

- A. Testing agency will report results of tests to the Design-Builder.
1. Electrical Tests:
    - a. Time-current characteristic tests shall be performed by passing three hundred percent (300%) rated current through each pole separately. Trip time shall be determined.
    - b. Instantaneous pickup current shall be determined by run-up or pulse method. Clearing times should be within four (4) cycles or less.
    - c. Insulation resistance shall be determined pole to pole, across pole and pole to ground. Test voltage shall be 1000 volts D.C.
  2. Test Values:
    - a. Insulation resistance shall not be less than fifty (50) megohms.
    - b. All trip times shall be adjusted to the values determined from the Short Circuit Coordination Study Report. Circuit breakers exceeding maximum three hundred percent (300%) time shall be replaced.
    - c. Instantaneous pickup current levels should be within twenty percent (20%) of manufacturer's published values.
- B. The following list includes but does not limit the required shop drawings and product data information that shall be submitted.
1. Amperage and voltage of all equipment and components.
  2. Busing materials and short circuit withstand rating and size and number of bus bars per phase, neutral and ground.
  3. A list of breakers and the interrupting duty of each class of breaker, plus original cut sheets.
  4. Structural support of switchboards.
  5. Gage of sheet metal enclosure and finish.
  6. Physical size, weight, elevation and plan drawings.
  7. One-line diagram of switchboard.
  8. Instructions for handling and installation of switchboard.
  9. Electrical characteristic including frame size, trip ratings, withstand ratings and time-current curves of all equipment and components.
- C. Shop drawings to show the electrical equipment layout and clearance in all electrical rooms and/or outdoors.

#### 1.3 REFERENCES

- A. ANSI C12 - Code for Electricity Metering.
- B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
- C. ANSI C57.13 - Requirements for Instrument Transformers.
- D. FS W-C-375 - Circuit Breakers Molded Case, Branch Circuit and Service.
- E. NEMA AB 1 - Molded Case Circuit Breakers.

- F. NEMA PB 2 - Dead Front Distribution Switchboards.
- G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Dead-front Switchboards Rated 600 Volts or Less.
- H. NEMA SG 5 - Power Switchgear Assemblies.
- I. Materials and/or installation shall meet or exceed the above referenced standards.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. The entire switchboard shall be of unit construction with all parts designed, manufacturer, and assembled by a single manufacturer to assure coordination between all items. All buses shall be copper.
- B. The design of all current carrying devices or parts of switchboards shall conform to the standard specified in the related sections of UL No. 891 and National Electrical Standards Institute (NEMA) Standard PB-2, except as these characteristics may be modified herein.
- C. The switchboards shall be floor mounted, self-supporting, dead-front and rear, front operated, front connected, distribution type, manufactured complete with all parts, fittings and equipment, including buses, circuit breakers, barriers, terminals, wiring and connections. The enclosure shall be 90 inches high, made of cold rolled steel on a structural shape, or formed, steel frame and shall be mounted on two 3 inch-5lb. continuous channel iron sills, which shall be closed at the ends between the two channels.
- D. All switchboard sections shall be a minimum of 24 inches deep and shall be constructed of California Electrical Code (CEC) gage steel. All holes, supports, studs and openings shall be standardized to enable interchange of interior and front cover units. All sections shall be fabricated with right angle corners, plumb edges and surfaces. All switchboard sections shall line up evenly, front and rear.
- E. The enclosure shall be chemically cleaned by parkerizing, bonderizing or phosphorizing as a unit after all welding has been completed. The enclosure shall then be painted with rust resisting primer coat of paint. The interior shall be finished with a coat of light grey, baked enamel.
- F. All wiring gutters shall extend the full length and depth of the switchboard.
- G. The switchboard shall be provided with cable pull section at the top or bottom of the switchboard, depending upon the location of the incoming and outgoing feeders. Provide a minimum 12 inches of vertical clearance between the cable terminal lugs bolted to the switchboard buses and the top and bottom of the switchboard enclosure. Horizontal pull sections and gutters shall be kept free and clear of buses. Where busses cross vertical pull sections, the busses shall be insulated.
- H. Bus bars, connection bars and wiring on the back of the switchboard shall be arranged so that maximum accessibility is provided for cable connections from the front.
- I. Electrical clearance between parts of opposite polarity, and between live parts and ground, shall conform to the California Electrical Code (CEC).
- J. Each distribution section shall be bused for the full connected load and for the full height of that section. Bussing in all sections shall extend to all spare circuit breaker "spaces". Buses shall be drilled for all future circuit breakers.



- K. All bus bars shall be 98% conductivity copper or aluminum. All bus bars and connections, except as noted herein, shall be applied on the basis of the minimum cross-sections required for the circuit ampere rating. Bus bar strength shall withstand strains imposed by starting and short-circuit current. Connections between horizontal and vertical runs of bus bars shall be made with the same size bars as the vertical run bars.
- L. Ampere ratings for rectangular bus bars shall be in accordance with the temperature rise standard of NEMA and UL. Bus size shall not be smaller than the main circuit breaker frame size.
- M. Busses shall be braced for a maximum 65000A unless otherwise noted. Busses bracing shall be increased based on the "System Short Circuit Study" which is requested in other Sections. Bracing shall be per NEMA and UL Standards.
- N. All connections between bus bars shall be of a bolted-type. All bus bars shall be accurately formed, and all holes shall be made in a manner which will permit bus bars and connections to be fitted into place without being forced.
- O. Bolts, nuts and washers used to maintain contact on bus and connection bars shall be non-ferrous material, zinc-electroplated steel, or of other corrosion resistant processed steel.
- P. Copper bus bars and connections shall be provided with silver-plated contacted surfaces. The surfaces silvered shall not be less than 0.0005-inches thick and shall not peel off under normal conditions.
- Q. The contact surfaces and studs of all devices to which bus connections are made shall also have silver-plated surfaces. The silver surfacing for these contacts shall be of the same thickness and applied in the same manner as described above. For stud connections, the threaded surface shall have silver applied to thickness of 0.0004 inches.
- R. Current carrying nuts shall be made of copper alloy having adequate conductivity and shall be of size to carry the circuit current without exceeding the temperature rise normally specified for copper. Current carrying nuts shall be silver-plated when they are used with connections that are silver-plated.
- S. A ground bus, with a cross-section equal to at least 25% of the capacity of the main bus rating, shall be located in the back of the switchboard assembly. Each housing of the assembly shall be grounded directly to this bus. Provide isolated ground bus in addition to ground bus as required. Neutral bus shall be 100% rated.
- T. All connections between bus bars shall be made by drilling and tapping the bus bars and attaching the breakers or jumper bars with cap screws.
- U. All bus and connection bars and current potential transformers shall be rigidly supported. No magnetic material shall be located between phase conductors.
- V. All nuts and connections shall be fitted with locking devices to prevent loosening.
- W. Load connections shall be provided with two-hole compression lugs, sized in accordance with the riser diagram, for the cable sizes indicated and shall be so located within the enclosure that not live parts are accessible from wiring gutters. All devices shown on drawings as specified herein, and necessary fuse blocks, terminal blocks and interconnecting wiring shall be factory installed. All groups of control wires leaving the switchboard shall be provided with terminal blocks with numbering strips. Clamp type terminals for all incoming and out-going cables shall have a UL stamp for copper conductors.
- X. Connections to current transformers, breakers or other devices or equipment in the panel and connected to the bus shall not be used for bus supports.
- Y. Arrangement of 3-phase bus bars shall be as follows, color coded for phase identification with a painted band, minimum 2 inch wide.

1. End of board: front to rear, A-B-C NEUT.
2. End of board: top to bottom, A-B-C NEUT.
3. Facing front of board: left to right, A-B-C NEUT.
4. Facing back of board: right to left, A-B-C NEUT.
5. Color codes as follows:

a. 208Y/120V, 3 phase 4W

- 1) Phase A - Black
- 2) Phase B - Red
- 3) Phase C - Blue
- 4) Neutral - White

Z. Molded Case Circuit Breaker:

1. Molded case circuit breakers shall be volt rated as required, bolt-on type. The operating mechanism shall be entirely trip-free, so that the contacts cannot be held closed against an abnormal over-current or short circuit condition. The operating handle shall open and close all poles of the breaker simultaneously and the breaker mechanism shall have a common internal trip bar to trip all poles simultaneously. The breaker shall meet applicable NEMA AB-1 standard and shall have a U.L. label showing U.L. tested interrupting rating exceeding the fault current available. Breakers shall include terminal lugs with U.L. label for copper.
2. Breakers 100 AMP through 400 AMP frame shall be thermal-magnetic trip with inverse time current characteristics. Breakers 225 AMP through 400 AMP shall have continuously adjustable magnetic pick-ups of approximately 5 to 10 times trip rating.
3. Breakers 600 AMP frame and above shall be 100% rated and have solid-state trip unit with minimum seven function complete with built-in current transformers. Breakers shall have easily changed trip rating plugs with trip ratings as indicated on the Drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breaker cannot be latched with rating plug removed. Breaker shall have built-in test points for testing long delay and instantaneous, and ground fault (where shown) functions of the breaker by means of a 120-volt operated test kit. Provide one test kit capable of testing all breakers 600 AMP and above. Solid state trip shall be with long time rating, long and short time delay, independently adjustable long and short time pickup, and adjustable instantaneous pickup.
4. For breakers 200 AMP through 3600 AMP trip, frame size shall be selected so that the trip size shall be at least 10% smaller than the frame size unless noted otherwise.
5. All circuit breaker interrupting capacity shall meet the minimum as calculated by the Design-Builder and from the result of the short circuit study, whichever is higher.
6. Breaker type shall be changed to meet short circuit and coordination study requirements.
7. Main circuit breaker shall be individually, vertically mounted unless otherwise noted.
8. Main circuit breaker frame size shall not be less than the bus size.
9. Circuit breaker with built-in fuse is not acceptable.

AA. Manufacturer: All major components and circuit breakers shall be of the same manufacturer as switchboard, distribution board and panelboard. Manufacturer shall be Eaton Cutler Hammer or equal.

BB. Switchboard shall be capable to increase the number of circuit breakers for future applications. Provide at least 35% additional space.

CC. 600A and higher distribution switchboards shall be floor standing type.

DD. Distribution switchboard construction and installation shall meet seismic Zone 4 requirements.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. The Contractor shall install all equipment per manufacturer's instructions, contract drawings and California Electrical Code.
- B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- C. The Contractor shall be responsible for ensuring that termination of conduits entering the top of switchboards constitutes a tight and continuous metal-to-metal contact by penetrating the finish paint on the inside of the enclosure.
- D. Conduits entering bottom of switchboard shall be terminated with a metal grounding bushing with neoprene throat insert. Each bushing shall be connected to the switchboard ground bus with a #4 insulated ground conductor.
- E. Provide a 3-inch high housekeeping pad for all switchboards. Pad shall be up to 3" inches wider than the base of switchboard.
- F. Include nameplates and warning signs as specified in other Sections.
- G. Provide permanent identification for each feeder and piece of equipment by means of plastic laminated nameplates.
- H. Furnish two sets of spare fuses of each rating, where fuses are called for.
- I. Furnish two sets of spare pilot lights.
- J. Install phase identification tape on all feeders within switchboards.

#### 3.2 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this Section.
  - 1. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
  - 2. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.

#### 3.3 FIELD ADJUSTMENTS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.
- B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor.

#### 3.4 MANUFACTURER'S CERTIFICATION

- A. A certified test report of all standard production tests shall be available to the Contractor.

END OF SECTION

## SECTION 26 24 16 – PANELBOARDS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide panelboards as specified.

#### 1.2 SHOP DRAWINGS SUBMITTALS

- A. Include a front elevation, indicate cabinet dimensions, make, location and capacity of equipment, integrated short circuit ampere rating, size of gutters, type of mounting, finish, and catalog number of locks and construction details. Catalog of all circuit breakers.

#### 1.3 REFERENCES

- A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
- B. FS W-P-115 - Power Distribution Panel.
- C. NEMA AB 1 - Molded Case Circuit Breakers.
- D. NEMA PB 1 - Panelboards.
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.
- G. Materials and/or installation shall meet or exceed the above referenced standards.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Provide panelboard cabinets flush or surface-mounted as noted on the Drawings, with bolt-on circuit breakers, with hinged lockable door, typewritten index card holders under plastic cover, copper busing, and main lugs or main protective device as indicated on the Drawings. Panels to have concealed hinge, latch and flush locks, keyed to operate from one key. Panelboards with a height greater than 3 feet shall have three trim bolts each side.
- B. Lighting, power and distribution panelboards shall be three phase, four wire, S/N 208/120V or as required. All panelboards shall be equipped with a ground bus. In addition to regular ground bus bar provide an isolated ground bus bar for all 120/208V panelboards as noted.
- C. All boxes shall be formed of galvanized steel, chemically cleaned, and all breaks in galvanizing shall be painted with metallic aluminum paint. Minimum size: 20" wide by 5-3/4" deep unless noted otherwise on the Drawings. All trims and doors shall be chemically cleaned. Front door and trim shall be finished with ANSI 61 light gray paint for surface or semi-recessed mounting, and shall be finished with a prime coat for flush mounting.
- D. Provide zinc chromate primer factory finish on the exposed trim of all flush mounted panels in corridors, offices and other public spaces.
- E. Protective devices, main, branch or sub-feed shall be bolt-on type circuit breakers as shown on the Drawings and panel schedules. Circuit breakers in panelboards shall be rated as shown on the Drawings, or higher as described in next Paragraph. As a minimum, 120/208V circuit breakers shall be rated 10,000 amperes symmetrical or higher as required.
- F. Minimum interrupting rating shall be increased based on the "System Short Circuit Study." Series connected rating is not acceptable.

- G. Equip each circuit feeding electrical discharge lamp with CEC lock-off device, unless lamps are within sight of panelboard, or have local switch. Non-switched emergency light circuits, fire alarm, security system and control circuits shall include "lock-on" devices.
- H. The main circuit breaker shall be installed vertically on the top or the bottom of panel. Installing the main at branch circuit location is not acceptable.
- I. Where a contactor relay or time switch is indicated to be included with or adjacent to a panelboard, it shall be in a separate box and mounted under a separate hinged lockable door. Where a panelboard or box has more than one door, a barrier and divider bar shall be installed between doors. Relays, time switches and control devices may be grouped under one door, but not with contactor.
- J. Panelboards shall be manufactured by Eaton Cutler Hammer or equal.

## 2.2 PANELBOARD CABINETS

- A. Panelboard cabinets shall be code gauge galvanized steel or blue steel; and fronts, doors, and trims shall be code gauge furniture steel. Cabinets shall have at least 6" high gutters at top and bottom where feeder cable size exceeds No. 4 or where feeder cable pass through the cabinet vertically. Cabinets shall have top and bottom gutters sized as required by the inspection department having jurisdiction but never less than "where more than one feeder enters the top or the bottom of the cabinets. Side gutters shall not be less than 4 inches wide. The width of the cabinets shall be minimum 20 inches.
- B. Doors shall be cut true, accurately fit opening and shall finish smooth across the joints. Rabbets concealed except for barrels and pins. Hinge flanges shall be welded to the door and trim. Each door shall be equipped with flush type lock, spring latching, Corbin lock for metal door, keyed to a Corbin CAT 60 key. All panelboard locks shall be keyed to operate from one key.
- C. Where contactors, time switches, and the control devices are required to be installed within panelboard cabinets, a separate compartment and door shall be provided at the top of the cabinet for such devices. The door shall be sized as required to permit removal of the contactor and other devices intact. Gutters shall be provided to the sides and top of the compartment.
- D. Panelboard Schedule: The Contractor shall prepare a neatly typewritten schedule with the number or name of the room or area or the machine served by each panel board circuit. The room numbers or name used shall be determined at the site. The schedule shall also indicate the panel designation, voltage and phase, the building and distribution panel or switchboard from which fed. The schedule shall be mounted in a frame under transparent plastic 1/32-inch thick on the inside of each panelboard cabinet door.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fronts shall be flush type unless otherwise indicated and shall be fastened to the cabinets with 1/4-inch 20 nickel plated oval headed machine screws and cup washers. Sufficient screws shall be installed to prevent buckling or warping of the panel front. Flush type fronts shall be aligned plumb and square and cabinet shall be drilled and tapped for cover screws at the site to accomplish this if necessary. Install nameplates at the front of each panelboard.
- B. All surfaces of surface mounting cabinets and fronts shall be given one coat of metal primer and a finish coat of baked on gray enamel.
- C. Panelboard cabinets shall be rigidly supported in place independent of the conduits with (2) row Unistrut.

- D. Panelboards located in mechanical areas shall have weatherproof gaskets on trims and doors.
- E. Obtain building room numbering system and include these room numbers in final typewritten panelboard directories.
- F. Install nameplates in accordance with the "Nameplates and Warning Signs" Section.
- G. From each flush mounted panelboard, route (4) 1-inch empty conduits into accessible ceiling space or in raised floor and cap for future use.

END OF SECTION

## SECTION 26 27 26 – WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SUBMITTALS

- A. Submit shop drawings and product data indicating Federal Specification No., amperage and voltage rating, materials, color and manufacturer's catalog sheet of each device.
- B. Submit shop drawings and product data indicating materials and thickness or gage of materials, color and manufacturer's catalog sheet of each device.
- C. Indicate application conditions and limitations of use stipulated by product testing agency specification under regulatory requirement.

#### 1.2 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices.
- B. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
- C. NEMA WD 6 - Wiring Device Configurations.
- D. Federal Specification WS-896-E and WC-596-F.
- E. Materials and/or installation shall meet or exceed the above referenced standards.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All devices shall conform to National Electrical Manufacturer's Association (NEMA) standards and shall be Underwriters Laboratories, Inc., (UL) listed and labeled and shall be "Specification Grade," meeting the requirements of Federal Specification WC-596-F for receptacle, and meeting the requirements of Federal Specification WS-896-E, for switches.
- B. Switches:
  - 1. Wall switches shall be specification grade, fully enclosed, quiet-type tumbler switches rated 20 amperes, 120-volt, bake-lite or composition, back and side wired, bumper pad, full rating for inductive or non-inductive loads and incandescent or fluorescent lighting loads.
  - 2. Single Pole Switches: Hubbell #HBL-1221, G.E. 5951-2G or Arrow #1991.
  - 3. Three-way Quiet Switches: Hubbell #HBL-1223, G.E. 5953-2G or Arrow #1993.
  - 4. Illuminated switches (light on with load off): Hubbell #HBL-1221-IL, G.E. SL122-2G or Arrow Hart #1991-IL.
  - 5. Key Switches: Hubbell #HBL-1221I, G. E. or Arrow hart #1991L.
  - 6. Wall switch and pilot lights shall be flush mounted combination wall type with switch and pilot light equipped with a 6-watt, 125-volt candelabra base lamp. The pilot light shall have a green jewel with brass rim flush mounted in the wall plate (light on with load on).
  - 7. All switches shall be of the same manufacture.
  - 8. Normal switch color is white. Switches controlling circuits connected to emergency power source shall be red.

C. Manual Wallbox Dimmers:

1. Fluorescent dimmers shall be 120 volts as required for circuit wiring. Rating shall be based on quantity of lamps controlled. Lutron "NOVA T" series, NTF-10.
2. Incandescent dimmers shall be thin-profile 120 volts and up to 1500 watts rating. Lutron "Nova T" series, "NT-1000 or NT-1500", color same as switches.
3. Wallbox dimmers shall be slider type with built-in switch and radio/T.V. interference filter. Dimmers shall be solid-state type.

D. Sensor Switch (Motion Sensor):

1. Wall sensor switch shall be infrared type, two wire connection (no neutral), 120 compatible with electronics ballast and working with 60 watt load. Model #WA-100 by Watt Stopper or equal. For rooms with bi-level switching provide a matching rocker type switch next to sensor under common cover-plate, if bi-level switching is not available with the sensor, color same as switches.
2. Ceiling sensor switch shall be infrared type. Cover 300 square feet for corner mounting. Model #WPIR by Watt Stopper or equal.
3. Ceiling sensor control unit (switch pack) shall be 120/277V and installed in J-box next to lighting circuit J-box.
4. Bathroom and non-occupied area sensors shall be ultrasonic type. Sensors shall cover up to 2000 square feet. Model #W-2000 series by Watt Stopper or equal.
5. Provide sensors with capability to control HVAC equipment (mixing boxes, VAV, etc), for all areas which have separate HVAC control capability.

E. Receptacles:

1. Single and duplex convenience receptacles shall be U-grounded type, 125 volts, side and back wired with binding screws only with double wipe contacts and spring steel back up clips. Rating 20 amperes, 125 V. Model #HBL-5362 of Hubbell, Arrow Hart, or equal. See Item 2 below for receptacle color.
2. Receptacles shall be red on emergency circuits, and isolated ground systems, and white for the rest (normal circuits).
3. The grounding contact shall be one piece brass and internally connected to the frame with ground terminal for external ground.
4. Ground fault receptacles shall be 20 amperes, 125 volt, duplex, three wire grounding with test and reset buttons. Suitable for feed-through wiring, color as defined above, Hubbell HBL-GF 5362 Series, Arrow Hart or equal.
5. Isolated ground type receptacles shall be HBL-IG 5362 Hubbell, Arrow Hart or equal, and shall conform to UL Standard #498 and NEC/NFPA requirements, ANSI #C73.
6. Poke-Thrus:
  - a. For multiple service (power and telecom) flush poke-thrus provide Walker #RC3 Series, assembled unit with prewired 20A receptacle and inserts to accept up to four discrete jacks for telecom system as required. Provide solid brass flange.
  - b. For single service (power) flush poke-thrus provide Walker #RC1 Series, assembled unit with 20A receptacle. Provide solid brass flange.
7. Wiring devices in exposed weatherproof boxes shall be the devices specified in this section, and shall be installed in "FS" or "FD" series condulets with weatherproof cast metal covers, and gaskets as required.
8. All receptacles shall be of the same manufacture.
9. Each receptacle installed outdoors, within 72" of sinks, in wet or damp areas, on roof, below grade (base-isolation level, elevator pits, etc), parking garage, janitor closets, and toilet rooms, shall have automatic 5 ma, individual ground fault (GFI) protection.



F. Plates:

1. Provide plates for all switches, receptacles, junction boxes, telephone and other outlets.
2. Provide engraved or etched plates for all lock switches, pilot switches, switches from which equipment or circuit controlled cannot be readily seen, three or more switches under a common plate and for switches as indicated.
3. Stainless steel plates shall be American Iron and Steel Institute (AISI) Type 302, with beveled edges, 0.040" thick with satin smooth finish. Hubbell # 97071 Series.
4. Plastic cover plate shall be high impact thermoplastic, high strength, scratch resistant, smooth and self-extinguishing, Hubbell "P1" Series or equal.
5. Where outlets are indicated to be weatherproof, provide an AISI Type 302 stainless steel, spring loaded, self-closing hinged covers appropriate to device orientation and type, Pass & Seymour #WP26 Series.
6. Galvanized steel plates shall be square or rectangular and hot dipped galvanized or sherardized, beveled edges and 0.040" thick. Galvanized steel plates shall be used in utility area.
7. Provide plates equipped with close fitting openings for the exact device to be used. Provide plates for telephone outlets equipped with bushed openings.
8. Cover plates of pressed steel outlet boxes in furred areas, attics, etc., or exposed in mechanical equipment rooms shall be of the same material as the outlet box.
9. Cover plates in locations concealed from public view shall have the circuit numbers and source feed point hand labeled with marking black pen (permanent marker).
10. Provide stainless steel cover plates unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount switches 42" above finished floor and vertically in all locations unless indicated otherwise.
- B. All convenience and telephone outlets mounted 18" above the floor shall be installed vertically. Install receptacle with the grounding terminal up. All receptacles mounted more than 18 inches above the floor over the bench top shall be installed horizontally with the grounding terminal to the left.
- C. California Electrical Code (CEC) sized (#12 minimum) bonding jumper shall connect grounded outlet box to receptacle grounding terminal on all flush mounted units.
- D. Each class of device shall be furnished by one manufacturer for total project. Mixing devices of different suppliers will not be permitted.
- E. Manual dimmers shall be installed in individual outlet boxes. Do not install in ganged boxes with other devices.
- F. All low voltage wiring for controls, occupancy sensors, etc., shall be in conduit.

END OF SECTION

## SECTION 26 28 16 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide switches, disconnect and safety as specified.

#### 1.2 SUBMITTALS

- A. Submit complete equipment product data and shop drawings with dimensions, equipment ratings for voltage capacity, horsepower and short circuit rating.

#### 1.3 REFERENCES

- A. ANSI/UL 198C - High-Intensity Capacity Fuses; Current Limiting Types.
- B. ANSI/UL 198E - Class R Fuses.
- C. FS W-F-870 – Fuse holders (For Plug and Enclosed Cartridge Fuses).
- D. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.
- E. NEMA KS 1 - Enclosed Switches.
- F. Materials and/or installation shall meet or exceed the above referenced standards.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Disconnect Switches:
  - 1. All disconnect switches shall be the "Heavy Duty" type and shall meet the latest edition of Federal Specification W-S-865.
  - 2. Provide all disconnect switches with devices enabling the switch to be locked in the open and closed positions.
  - 3. Externally operable safety switches shall have quick-make, quick-break mechanism, capable of switching 10 times the switch rating, and with cover interlocks with defeat mechanism for maintenance. Provide switches with number of poles, ampere, voltage and HP rating, types of enclosures and fusible or non-fusible as indicated and as required for the particular application. Provide National Electric Manufacturer's Association (NEMA) I enclosures for interior locations and NEMA 3R enclosures for exterior or wet locations unless otherwise indicated. Switches have a dual rating when used with dual element fuses shall have rating so indicated on the metal plate.
  - 4. Provide UL listed current limiting type RK5 fuses where required. Disconnect switch shall be equipped with rejection kit to reject all but Class "R" fuses.
  - 5. Provide circuit breaker with enclosure as required.
- B. Fractional Horsepower Manual Control Switches:
  - 1. Fractional Horsepower Manual Starters shall be motor rated tumbler switches, rated up to 1 HP 120 VAC (1P or 2P).
  - 2. Manual Starter Switches shall be equipped with integral overload protection.
  - 3. Manufacturers: Eaton Cutler Hammer or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switches, disconnects and safety, where required.
- B. Securely fasten to structural members or channel support.
- C. Install manual motor starters surface mounted in equipment rooms and non-finished areas.  
Where installed above ceilings, access panels shall be provided.

END OF SECTION

## SECTION 26 33 23 – CENTRAL BATTERY EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes UPS central battery inverters with the following features:
  - 1. Output distribution section.
  - 2. Internal maintenance bypass/isolation switch.
  - 3. External maintenance bypass/isolation switch.
  - 4. Multiple output voltages.
  - 5. Emergency-only circuits.

#### 1.2 ACTION SUBMITTALS

- A. Product Data:
  - 1. Electrical ratings, including the following:
  - 2. Capacity to provide power during failure of normal ac.
    - a. Inverter voltage regulation and THD of output current.
    - a. Rectifier data.
    - b. Transfer time of transfer switch.
    - c. Data for specified optional features.
  - 3. Transfer switch.
  - 4. Inverter.
  - 5. Battery charger.
  - 6. Batteries.
  - 7. Battery monitoring.
  - 8. Battery-cycle warranty monitor.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Field quality-control test reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. 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.
- B. Central Battery Inverter System: UL 924 listed.
- C. Comply with NFPA 70 and NFPA 101.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
  - 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
    - a. Standard, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
      - 1) Full Warranty: One Year
      - 2) Pro Rata: Nine years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
  - 1. Crucial Power Products.
  - 2. Cooper Sure-Lites
  - 3. Or Equal.

### 2.2 INVERTER PERFORMANCE REQUIREMENTS

- A. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
  - 1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
- B. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 seconds or less from normal supply to battery-inverter supply.
  - 1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
- C. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.
  - 1. Automatic Operation:
    - a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.

- b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
  - c. If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
  - d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
  - e. If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
2. Manual Operation:
- a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
  - b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

### 2.3 SERVICE CONDITIONS

- A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
- 1. Ambient Temperature for Electronic Components: 32 to 98 deg F
  - 2. Relative Humidity: 0 to 95 percent, noncondensing.
  - 3. Altitude: Sea level to 4000 feet

### 2.4 INVERTERS

- A. Description: Solid-state type, with the following operational features:
- 1. Automatically regulate output voltage to within plus or minus 5 percent.
  - 2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
  - 3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
    - a. THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
  - 4. Output Protection: Current-limiting and short-circuit protection.
  - 5. Surge Protection: Panelboard suppressors.
  - 6. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
  - 7. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

### 2.5 BATTERY CHARGER

- A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

## 2.6 BATTERIES

- A. Description: Standard, valve-regulated, recombinant, lead-calcium batteries.
  - 1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

## 2.7 ENCLOSURES

- A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

## 2.8 SEISMIC REQUIREMENTS

- A. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces.

## 2.9 CONTROL AND INDICATION

- A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
- B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
- C. Indications: Labeled LED
  - 1. Quantitative Indications:
    - a. Input voltage, each phase, line to line.
    - b. Input current, each phase, line to line.
    - c. System output voltage, each phase, line to line.
    - d. System output current, each phase.
    - e. System output frequency.
    - f. DC bus voltage.
    - g. Battery current and direction (charge/discharge).
    - h. Elapsed time-discharging battery.
  - 2. Basic Status Condition Indications:
    - a. Normal operation.
    - b. Load-on bypass.
    - c. Load-on battery.
    - d. Inverter off.
    - e. Alarm condition exists.
  - 3. Alarm Indications:
    - a. Battery system alarm.
    - b. Control power failure.
    - c. Fan failure.
    - d. Overload.
    - e. Battery-charging control faulty.
    - f. Input overvoltage or undervoltage.
    - g. Approaching end of battery operation.
    - h. Battery undervoltage shutdown.
    - i. Inverter fuse blown.
    - j. Inverter transformer overtemperature.

- k. Inverter overtemperature.
  - l. Static bypass transfer switch overtemperature.
  - m. Inverter power supply fault.
  - n. Inverter output overvoltage or undervoltage.
  - o. System overload shutdown.
  - p. Inverter output contactor open.
  - q. Inverter current limit.
4. Controls:
- a. Inverter on-off.
  - b. Start.
  - c. Battery test.
  - d. Alarm silence/reset.
  - e. Output-voltage adjustment.
- D. Include the following minimum array:
- 1. Ready, normal-power on light.
  - 2. Charge light.
  - 3. Inverter supply load light.
  - 4. Battery voltmeter.
  - 5. AC output voltmeter with minimum accuracy of 2 percent of full scale.
  - 6. Load ammeter.
  - 7. Test switch to simulate ac failure.
- E. Enclosure: Steel, with hinged lockable doors, suitable for floor mounting. Manufacturer's standard corrosion-resistant finish.
- 2.10 OPTIONAL FEATURES
- A. In this Article, delete optional features not required and coordinate those retained with Drawings. See Evaluations for discussion of these items. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
- B. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.
- C. Maintenance Bypass/Isolation Switch: Load is supplied, bypassing central battery inverter system. Normal supply, electromechanical transfer switch, and system load terminals are completely disconnected from external circuits.
- D. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
- 1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
  - 2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
  - 3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.
- 2.11 OUTPUT DISTRIBUTION SECTION
- A. A. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.



### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install system components on concrete base and attach by bolting.
  - 1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
  - 2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems"
  - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 5. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components.
- D. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding"
  - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- E. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

#### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
  - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
  - 2. Test manual and automatic operational features and system protective and alarm functions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

## **DIVISION 26 50 00 – LIGHTING FIXTURES AND ACCESSORIES**

### **PART 1 – GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Conditions of the Contract and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. General:
  - 1. Section specifies requirements for luminaires, lamps, ballasts, and accessories.
  - 2. The Contractor shall be responsible for luminaire quantities, lengths and clearances required and shall inform the Architect in writing, at the time the bid submission is made, of discrepancies or variances found with fixtures or details specified herein or in the luminaire schedule and other contract documents.

#### **1.3 STANDARDS**

- A. Codes: Luminaires, components, and installation shall be in accordance with the American National Standards Institute, the latest revision of the National Electrical Code (N.E.C.) and applicable federal, state, and local codes and regulations.
  - 1. Lamps shall be in accordance with the Energy Policy Act of 1992 (Public Law #102-486).
- B. U.L. Listing:
  - 1. Luminaires, ballasts, transformers, and other electrical components shall be manufactured in strict compliance with the appropriate requirements of the Underwriter's Laboratories, Inc. and others that may be applicable. The appropriate Underwriter's Laboratories, Inc. labels shall be affixed to luminaires.
  - 2. The Contractor shall be responsible for coordinating the characteristics and the appropriate U.L. labeling of luminaires and their components with the ambient conditions which will exist when the luminaires are installed.

#### **1.4 SUBMITTALS**

- A. Procedure: In accordance with Division One.
- B. Shop Drawings and Product Data Submittals:
  - 1. Within fourteen days of contract award, successful Contractor shall submit a complete list of lighting products intended to be furnished with manufacturer and catalog designations, along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of specified product may adversely impact the construction schedule, it shall be brought to the attention of the owner at this time. Request for fixture substitution on the basis of delivery schedule will not be permitted.
  - 2. Within fourteen days of bid award, the Contractor shall provide a complete list of lamps, which will be furnished on the project. This list shall be organized alphabetically by the luminaire type indicated on the luminaire schedule, and include the manufacturer and exact model number of each lamp. Up to three samples of any listed lamp shall be supplied at no additional cost to the project, if so requested by the specifier.
  - 3. Alternate products other than those listed by name in the specification will not be considered without prior written consent from the Lighting Designer.
  - 4. Submit shop drawings and product data in accordance with the requirements of the general conditions and as described herein and elsewhere in the contract documents.
  - 5. The Contractor shall submit data for approval of the Architect, detailed shop drawings and product data for luminaires specified herein and elsewhere in the contract documents. Luminaires shall not be installed without the approval of its shop drawings, product data and/or sample.

6. Shop drawings and product data shall indicate the name of the project, fixture type, manufacturer's name, luminaire catalog number and catalog number for lampholders, ballasts, diffusers, internal protective components and all necessary information including, but not limited to: clearances, dimensions, components, mounting hardware, materials and weights; other pertinent information, to show compliance with contract documents with regard to metal thickness and support methods.
  7. Prior to fabrication and submittal of the shop drawings and product data, the Contractor shall coordinate luminaires and conduit entries with equipment, ducts, pipes, openings, etc.
  8. Custom luminaire fabrication details shall be drawn at either full size or half-size scale. Fixture fabrication details shall illustrate a minimum of three critical views indicating fabrication and assembly methods, materials, and materials' gauges and finishes, and specifications of lighting equipment and appropriate electrical, mounting and accessory hardware.
  9. Where luminaires are mounted in continuous rows or in architectural coves, shop drawings shall indicate exact luminaire locations, layout, connecting components, coupling plates, changes in elevation, corner details, assembly methods, and reinforced concrete base details.
  10. Submit product data which includes luminaire type, luminaire illustration with mounting details, luminaires certification of suitability for use in locations indicated, and photometric test reports which include the following:
    - a. Complete candlepower summary with graphical and numerical data in 5 degree increments for up and down quadrants and at 22-1/2 degree azimuth increments including normal and parallel.
    - b. Visual comfort probability data.
    - c. Coefficients of utilization data.
    - d. Luminaire efficiency.
    - e. Lamp description.
    - f. Lamp lumen output.
    - g. Zonal lumens and percentages.
- C. Samples
1. Upon request, submit samples of custom luminaires, modified, and substitution items for the purpose of ascertaining photometric performance, quality of visible parts and details, maintenance features, methods of installation, and safety features. These samples shall be submitted for approval at no expense to the Owner, with transportation prepaid. The samples will be returned to the Contractor after the review has been completed at the expense of the Contractor.
- D. Substitutions
1. Substitutions for the specified lighting products are not acceptable and will not be considered. Failure to include one of the specified products as a part of the base bid may, at the discretion of the owner, invalidate the entire lighting product bid and exclude the contractor from further consideration.
  2. Should the Contractor elect to consider products other than those specified, the items must be submitted fourteen days in advance of the bid. Failure to submit within that deadline constitutes a guarantee that the specified products will be supplied. The lighting designer will invoice the contractor, at senior designer hourly rates, to review any product not listed in the specification. Submittal of a bid for this project shall include a written acknowledgment of these terms from the contractor.
  3. Substitutions shall be submitted in accordance with the requirements of the general conditions and as described herein and elsewhere in the contract documents.
  4. The Manufacturer shall submit, upon request, a prototype sample of the substitute luminaire for evaluation of compliance with the contract documents. Shop drawings will not be acceptable in place of the prototype. A submittal for evaluation shall be an operable 120 volt non-returnable sample, complete with lamp(s), 72 inch grounded cord and plug and the specified finish.

5. The Architect will be the sole judge in determining whether the prototype sample complies with the contract documents and reserves the right to disqualify proposed manufacturer or submitted item.
6. Photometric test reports shall be submitted for each luminaire offered in substitution for a luminaire specified.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL LUMINAIRE DESIGN AND CONSTRUCTION**

- A. Manufacture luminaires to the specifications described above, hereafter, and as indicated in the luminaire schedule and contract documents. Acceptable manufactures are listed in the luminaire schedule shown on the drawings.
- B. Provide proper thickness of code gauge sheet steel so that luminaires are rigid, stable, and will resist deflection, twisting and warping under normal installation procedures, re-lamping, and maintenance.
- C. Luminaire designs shall include, as applicable, plaster frames, trim rings, shrouds, flanges, backboxes, support hardware, and other components required for proper installation of the luminaire.
- D. Luminaires with covers, cones, or diffuser frames, which are to be mounted above twelve feet from the finished floor level, shall be provided with safety chains or other acceptable backup means of support to properly secure such items to main housing.
- E. Fixtures shall be Underwriter Laboratory approved for their application and location and have the appropriate U.L. label adhered to the fixture visible within the housing of each fixture.
- F. Rows of luminaires shall be designed with concealed splice plates and shall be free of light leaks. Components such as reflectors, trims, diffusers and other visible items shall be properly aligned with no overlaps, gaps, or other imperfections.
- G. Adjustable fixtures interior and exterior shall provide methods to lock fixture in place. This includes rotation and tilt adjusting.
- H. Hardware shall be concealed where it is appropriate, unless it is a design feature.
- I. Where hardware is exposed the hardware is to be painted to match adjacent surfaces unless otherwise noted.
- J. Materials, accessories, and other related fixture parts shall be new and free of defects, which may impair their character, appearance, strength, ability, or function. Fixtures must be protected from damage from the time of fabrication until final acceptance of work.
- K. Contractor is responsible for coordination of special mounting conditions for custom fixtures and must supply necessary mounting devices.
- L. Fixtures shall be completely wired at the factory. Fixtures shall come with electrical wiring in accordance with local codes and in accordance with actual installation requirements.
- M. Provide neoprene gasketing, stops, and barriers where required to prevent light leak and/or water and water vapor penetrations. Luminaires installed in the following locations shall have neoprene gasketing:
  1. Locker rooms
  2. Aquatic areas
  3. Aquatic mechanical equipment rooms
  4. Kitchens
  5. Exterior
- N. Provide finished product with smooth clean ground metal edges, trims, and frames as well as tight fitting connections, hinges, and closures.

- O. Provide access for servicing the installed luminaire and for replacement of electrical parts without removal or disassembly of the luminaire.
- P. Unless otherwise noted, provide emergency battery packs, emergency quartz re-strike, or stand-by systems as required for luminaires connected to emergency circuits.
- Q. High intensity discharge luminaires, connected to emergency circuits, shall be provided with a quartz re-strike or stand-by system which is activated during loss of power until the high intensity discharge lamp returns to full light intensity.
- R. High intensity discharge luminaires shall be completely enclosed, unless otherwise noted.
- S. Where acrylic is used for lenses, refractors, and diffusers with luminaires with H.I.D. sources, the luminaires shall be designed not to exceed a 65°C luminaire ambient temperature.
- T. Incandescent luminaires utilizing tungsten halogen sources shall be designed and constructed so that lamp seal temperatures do not exceed 350°C. at an ambient of 25°C when tested in accordance with U.L. Standard #57, and shall maintain an operating bulb wall temperature of approximately 600°C and not less than 250°C.
- U. Low voltage fixtures which use a remote transformer must be supplied with transformers as necessary to complete a working installation. Transformers must be supplied by the fixture manufacturer or approved by the fixture manufacturer to maintain the U.L. rating.
- V. Lead wires for luminaires utilizing tungsten halogen lamps shall be rated for not less than 200°C operation, and shall be rated for 250°C when temperature warrants. Minimum individual fixture wiring shall be number 18 gauge. Terminate wiring for recessed fixtures, except fluorescent units, in external splice box.
- W. Temperature at any point on reflectors of tungsten halogen luminaires shall not exceed 205°C.
- X. Incandescent luminaires supplied for recessing in suspended ceiling shall be supplied with pre-wired junction boxes.
- Y. Luminaire doors shall be provided as follows: Positive light seal, concealed safety hinges, and inconspicuous "positive spring loaded" holding latches, which are hingeable from either side and operable without the use of tools.
- Z. Where luminaires are mounted in tandem in continuous uplight or downlight coves, the Contractor shall field coordinate fixture quantity and length required to provide a continuous band of light without gaps to within 6" of row ends.

## **2.2 CUSTOM FIXTURES**

- A. Custom fixture manufacturers must supply working sample and complete shop drawings to design team for review. Sample fixtures will become property of the Client or their design team.
- B. Fixtures shall be U.L. approved for their proposed location.
- C. Exposed hardware shall be concealed where appropriate unless as a design feature.
- D. Custom fixture manufacturers shall have a minimum 5 years of experience in the design and manufacturing of lighting fixtures of the type, quantity and quality shown. Prequalification submissions must include a list of completed projects, dated catalog pages or drawings indicating length of experience.
- E. Materials, accessories and other related fixture parts shall be new and free of any defects which in any manner may impair their character, appearance, strength or ability and function effectively protected from damage or injury from the time of fabrication until final acceptance of work.
- F. Sheet metal shall be free from tool marks, and dents and shall have accurate angles as sharp as compatible with the gauge of the required metal. Intersections and joints shall be formed true of adequate strength and structural rigidity to prevent distortion after assembly.

- G. Housing shall be so constructed that electrical components are easily accessible and replaceable without removing fixtures from their mountings or disassembly of adjacent construction.
- H. Fixtures shall be completely wired at the factory. Fixtures shall come with electrical wire whips in accordance with local codes and in accordance with actual installation requirements.
- I. Leaks within fixtures and between fixtures and mounting surface will not be tolerated.
- J. Steel and aluminum fixtures, screws, bolts, nuts and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, hardware shall be stainless steel or bronze. Fixtures must be assembled and gasketed properly to prevent galvanic action.
- L. Decorative fixtures shall be provided with a UL Approved lamp/ballast combination as well a ballast that is warrantied to work with the specified lamps. Ballasts should also contain an "End of Life" sensing feature to prevent firing after lamp burn out.

### **2.3 SUSPENDED FIXTURES**

- A. Where fixtures are mounted in a continuous row, fixtures eight feet in length shall have stems placed within 2 feet of fixture ends. Stems shall be spaced symmetrically. A fixture four feet or three feet in length, placed in rows shall have a stem connected to the center fixture.
- B. Individual fixtures that are four feet in length shall have two stems placed approximately three inches from the end.
- C. Suspended fixtures shall be stem-mounted and shall be free to swing 20 degrees in any direction. Ceiling swivels shall be of the ball aligner type permitted on the drawings. Chain suspension may be used only where specifically permitted on the drawings. Chain shall be heavy duty, nickel-plated suitable for the weight of specific fixtures.
- D. Provide redundant support for pendant-mounted fixtures.

### **2.4 TRACK**

- A. Contractor to assemble track fixtures and accessories prior to installation.
- B. Contractor will supply necessary connectors and adapters and necessary mounting and electrical feed equipment.
- C. Contractor to mount fixtures to track. Final aiming to be done with the guidance of the Lighting Consultant.

### **2.5 FLUORESCENT LUMINAIRES**

- A. Where fluorescent fixtures are surface mounted, they shall be labeled for such and a minimum of one half inch air space shall be maintained between the top of the fixture and the mounting surface by an approved means.
- B. Surface mounted fluorescent fixtures shall be supported by light weight channel attached by tie straps to two members of the ceiling suspension system. Surface mounted fixtures mounted on sheet rock or plaster ceilings or low density acoustical tile ceilings shall be mounted with metal spacers between fixture and ceiling.
- C. Recessed fluorescent fixtures shall be installed with 6 foot flexible conduit connecting the fixture housing and the outlet box.
- D. Fluorescent fixtures flush mounted in exposed t-grid suspended acoustical tile ceilings shall be of the lay-in type which shall rest on and be supported by the main runners of the ceiling support system at each end with clips intended for that purpose.
- E.

Lamp Type	Recommended
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Four-Foot Lamps	
T8, 32 watts	2800 lumens or more
T12, 34 watts	2800 lumens or more
Eight-Foot Lamps	
T8,59 watts	5700 lumens or more
T12,60 watts	5600 lumens or more
U-Tube Lamps	
T8/U,31-32 watts	2600 lumens or more
T12/U,34 watts	2700 lumens or more

## 2.6 LOW VOLTAGE LIGHTING

- A. Where remote transformers are specified, transformers must be installed in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100 degrees Fahrenheit (38 degrees Celsius).
- B. Transformers shall be rated for operation on the electrical system voltage to which they are shown connected.
- C. Transformers should be mounted as close to the feed lampholders as practical to keep the secondary feed as short as possible.
- D. Low voltage transformers shall be fused on the primary and secondary side with protection devices sized as appropriate to conductors, lamps, and transformers.
- E. Contractor is responsible to lay out and install low voltage systems to prevent excessive light loss due to voltage drop.
- F. Contractor to install the system to meet local codes.

## 2.7 NEON AND COLD CATHODE

- A. The secondary cables must be installed so as not to touch metal other than the aluminum conduit through which it runs. GTO cable in 1/2" or 3/4" aluminum conduit must be used. Tight bends, angle connectors, or current-carrying pulling compounds are not permissible. Long secondary feeds in metal conduit create a capacitor effect which can lead to audible noise, cable, and transformer failures, and shortened lamp life.
- B. If conduit is used, it must be isolated from construction to reduce the audible noise that could be produced. Conduits must be installed a minimum of 3" apart.
- C. Lamps must be kept 1 1/2" from metal. Electrical Contractor must make sure that lamps are making secure mechanical and electrical contact in the lampholder.
- D. Shop drawings must be received showing placement of lampholder for use by other Contractors.
- E. A copy of the latest drawings must be given to the Owner for their maintenance and lamp replacements.
- F. Operation of a transformer under open circuit conditions (defective, broken, or missing lamps, or broken secondary feed or interfeed) will cause transformer failure unless the transformer is turned off. An electrical jumper may be installed in place of the lamp to allow the rest of the circuit to operate until the lamp is replaced.

- G. Neon or cold cathode installation may only be done by vendors who can demonstrate 5 years experience in architectural applications. Vendors to be approved by the Architect.
- H. Transformers must be installed in accessible areas large enough to dissipate the heat of the transformer. Temperatures should not exceed 100 degree F (38 degree C). Transformers should be mounted as close to the feed lampholders as practical to keep the secondary feed as short as possible.
- I. To avoid transformer hum, neon and cold cathode transformers are to be enclosed in a cavity of a double layer of sheet rock with access panels or particleboard. Transformer shall be provided with standard no. 16 gauge steel housing with conduit knockouts and vent holes.
- J. Neon, cold cathode, and low-voltage transformers shall be fused on the primary side at one and one half (1/2) amp over the highest current draw when dimmed as measured with an amp probe. This fuse may be on the in-line type and can be installed in the dimmer cabinet or the transformer enclosure, whichever is most accessible. The enclosure should be marked on the outside to show what fused circuits are inside. This fusing shall be the electrical Contractor's responsibility.
- K. Neon is to be installed in such a manner as to prevent arcing or flickering.

## **2.8 LENSES**

- A. Plastic used for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohm & Haas, Dupont, or acceptable equal, unless otherwise noted.
- B. Glass used for lenses, reflectors, diffusers, and luminaires shall be tempered for high impact and heat resistance. The glass shall have a transmittance of not less than 88%, unless otherwise indicated. For exterior luminaire use tempered borosilicate glass Corning #7740 or acceptable equal.
- C. Lenses, louvers, and other light diffusing elements shall be removable and positively held so that hinging or other normal motion will not cause them to drop out.
- D. Lenses shall be turned over to the Owner clean and free of dust or finger prints.
- E. Spread lenses shall be provided with notches or locking devices to insure that lens orientation is not disturbed during luminaire lamp replacement or cleaning.
- F. Unless otherwise noted, metal halide luminaires shall be provided with heat and shock tempered glass enclosures capable of containment of hot quartz arc tube particles as recommended by luminaire and lamp manufacturers.

## **2.9 LAMPS**

- A. Provide lamps as indicated on the luminaire schedule and the applicable contract documents.
- B. Lamps of a given type shall be produced by one manufacturer.
- C. MR16 and MR11 lamp types must have an integral cover glass if installed in a fixture which does not provide a protective lens.
- D. Linear fluorescent lamps shall be T-8, energy saving type with electronic ballasts unless otherwise noted.
- E. Provide 10% spare lamps for fixtures.
- F. Fluorescent or incandescent lamps not protected by suitable lens diffusers and used in dining areas, kitchens, food server areas, food display areas, bars, food counters or other applicable eating or drinking areas shall be fully protected with Teflon coating, tube guards, or other means as required by the N.E.C. Teflon coating shall be as provided by Shatter-Shield or equal.
- G. Incandescent lamps shall be 130V inside frosted unless otherwise specified.



- H. Provide rough service lamps for fixtures located in plenum air chambers and elevator or escalator pits.

## **2.10 FLUORESCENT BALLASTS AND HIGH INTENSITY DISCHARGE BALLASTS**

- A. Fluorescent and high intensity discharge lamp ballasts shall conform to the following:
1. U.L. and ANSI specifications with labels and/or symbols of approval by the U.L. and certification by C.B.M. as tested by E.T.L.
  2. Ballasts shall be rated for operation on the electrical system voltage to which they are shown connected.
  3. The component parts shall be designed, fabricated, and assembled in accordance with the N.E.C. and other applicable codes.
  4. Ballasts shall provide safe and reliable operation of the specified lamps.
  5. Ballasts installed within the same luminaire type shall be identical.
  6. Fluorescent lamp ballasts shall be rigidly mounted to the inside of the top of the luminaire housings, with ballast surfaces and housing in complete contact for efficient conduction of ballast heat to prevent overheating or cycling. Ballasts shall be readily removable for replacement.
  7. Ballasts shall be designed for operation at 60 Hz. nominal, and shall operate at the nominal voltages indicated on label.
  8. Secure ballasts firmly in luminaires to prevent vibrations.
  9. Contractor shall provide ballast with operating voltage compatible with branch circuit voltage as shown on contract drawings.
  10. Unless otherwise noted, ballasts shall be electronic and comply with the following specifications.
  11. Unless otherwise noted, ballasts shall be factory installed and wired.
  12. Fluorescent ballasts installed in fixtures outdoors or in enclosed loading docks shall have an ambient temperature rating of 0 °F.
  13. Ballasts for HID fixtures shall be high power factor, regulating type, with voltage regulation of 10%, (+7.5%, -10% for 400W or 1000W high pressure sodium) and crest factor of not more than 1.8. Primary starting current shall not exceed operating current.
  14. HID ballasts in luminaires installed out of doors shall have ambient temperature rating of -20 °F.
  15. HID ballasts for recessed HID fixtures installed indoors shall be encapsulated core and coil type with vibration dampening mounting.
  16. Fluorescent T8 lamp ballasts
    - a. Shall be capable of starting and maintaining operation at a minimum of 50°F, unless otherwise indicated.
    - b. Total harmonic distortion (THD) shall be less than 15%.
    - c. Input wattage: 62W or lower when operating two F32T8 lamps, 92W or lower when operating three F32T8 lamps, 115W or lower when operating four F32T8 lamps.
    - d. Provide three and four lamp fixtures with two ballasts per fixture to accommodate multilevel switching where indicated on drawings.
- B. Electronic ballasts shall conform to the following:
1. Ballasts shall be integrated circuit type as manufactured by Advance (Mark V) or approved equals, unless otherwise noted in fixture specification.
  2. Ballast shall have a frequency of operation of 20 KHz or greater, and operate without visible flicker.
  3. Ballasts shall withstand 4000 volt surges as specified in ANSI C62.41.
  4. Light level output shall be continuous, even and flicker-free over the entire dimming range.
  5. Ballast shall be inaudible in a 27dB ambient throughout the dimming range.
  6. Ballast shall be capable of striking lamps at any light level. This shall be accomplished without first flashing to full light.
  7. Ballasts must comply with FCC Part 18 regulations for non-commercial RF lighting devices.

8. Ballasts shall be CSA certified.
  9. Ballasts shall have a power factor of 95% or above.
  10. Ballasts shall be sound rated "A".
  11. Ballasts shall have an average lamp current crest factor below 1.4.
  12. Ballasts shall maintain constant light output over operating ranges of 90V to 145V (120V ballasts) and 200V to 320V (277V ballasts), 50/60 Hz.
  13. Ballasts shall have a sequenced start progression which first heats cathode filaments and then ignites the lamp to ensure rated lamp life is not diminished.
  14. Ballasts shall withstand line transients as defined in ANSI/IEEE C62.41, Category A.
  15. Ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, for non-consumer equipment.
  16. Where applicable, ballasts shall meet minimum efficacy standards of Public Law No. 100-357, National Appliance Energy Conservation Amendments of 1988, and Canadian Efficiency Standards.
  17. Ballasts power factor shall be 85% or above.
  18. Ballasts shall have a full replacement warranty of 5 years from date of manufacturer.
- C. Fluorescent dimming ballasts shall conform to the following:
1. Ballasts shall be of the Hi-Lume series by Lutron or approved equal.
  2. Electronic dimming ballasts and controls shall be made by the same manufacturer.
  3. Dimming shall be smooth and continuous without flicker down to 1% light output unless otherwise specified.
  4. Ballasts shall be capable of striking lamps at any light level without first flashing at full light.
  5. Different lamp lengths of the same lamp type shall dim evenly when controlled by the same dimmer.
  6. Ballasts shall be inaudible in a room with 27 decibel ambient noise level, throughout the full dimming range.
  7. Ballasts shall comply with FCC Part 18 regulations and shall not interfere with other properly installed electrical equipment.
  8. Ballasts shall be Class "P", and meet ANSI C62.41 standards for surge protection.
  9. Ballasts shall have a Class A sound rating.
  10. Ballasts shall have a power factor greater than 90%.

Lamp Type	# of Lamps	Recommended BEF
Four-Foot and U-Tube Lamps		
T5, T8,32 Watts	1	2.54 or higher
	2	1.44 or higher
	3	0.93 or higher
	4	0.73 or higher
T12,34 Watts	1	2.64 or higher
	2	1.41 or higher
	3	0.93 or higher
Eight-Foot Lamps		
T5, T8,59 Watts	2	0.80 or higher
T12,60 Watts	2	0.80 or higher

- D. Battery ballast/inverters shall conform to the following:

1. The electronic emergency power assembly installed in fluorescent fixtures designated as emergency or egress lighting and shall operate two 40W rapid start lamps at approximately 40% of rated output for a minimum of 90 minutes upon failure of the normal power system.
2. The assembly shall consist of two modules mounted within the ballast housing compartment of the fixture. One module shall contain nickel-cadmium cells connected to provide a minimum twenty-four watt hours of battery capacity when fully charged. The battery module shall contain an automatic low voltage cut out circuit to protect module from excessive discharge. The other module shall contain electronic components and circuitry for fluorescent lamp operation, battery, recharging, transfer mechanism, and signal facilities to indicate the complete system is in a "ready" state.
3. A light emitting diode shall be positioned within the fixture to provide a visual indication that the emergency power system is operable. The output of the diode shall be a bright red glow, which shall be visible through the fixture lens or diffuser.
4. A test button shall be provided adjacent to the visual signal, to simulate power failure.
5. The system shall be designed to transfer to emergency power operation when the line voltage of the circuit drops to 75% of normal.
6. The system shall be for use on the voltage of the branch circuit to which the fixtures are connected.

## **2.11 LIGHTING CONTROLS**

- A. Photo controls shall conform to the following:
  1. Photo control shall be for use on system voltage to which they are shown connected.
  2. Switching mechanism shall be hermetically sealed and shall be calibrated to close circuit when illumination drops below two-foot candles and open circuit when illumination exceeds five-foot candles.
  3. Switching mechanism shall contain delay feature to prevent circuit opening in transient illumination such as headlights from passing vehicles.
  4. Photocell shall be rated at not less than 1800-volt amps with standard EEI-NEMA 2-3/4" ID locking base.
  5. Control shall be mounted on twist lock receptacle on conduit fitting where indicated on the drawings.
  6. When mounted on roof locate device twelve inches above roof and orient photo control light sensing element north.
- B. Time switches shall conform to the following:
  1. Time switch used for control of exterior lighting shall be twenty four hours type with skip a day feature reserve spring for maintaining time schedule during power outage and astronomical dial factory set for latitude of project.
  2. Time switch enclosure shall be NEMA One weatherproof.
  3. Operation shall be for 277 volt lighting circuits with 277 volt control circuit.
  4. Time switch shall be four pole momentary contacts.
  5. Where number of lighting circuits to be controlled exceeds number of time switch load contacts, provide auxiliary lighting contactor to control additional circuits.
- C. Magnetic contactors shall conform to the following:
  1. Magnetic contactors shall be multi-pole, mechanically held, electrically operated with contacts rated for not less than twenty amps at 480 volts A.C. or Tungsten load within a NEMA 1 enclosure.
  2. Separate contactors shall be provided for each control function.
  3. Contactors shall break underground conductors of circuits being controlled. Use multiple contactors with operating coils in parallel when number of contacts required exceeds contactor pole limit.
  4. Contactor shall have coil clearing contacts.
  5. Control coil shall be rated 277V.

6. Contactor shall be U.L. listed for short circuit withstand rating of the source panel serving the contactor load circuits.
- D. Exterior lighting shall be controlled by lighting control center to provide lighting control by level of exterior illumination as well as by time control.
- E. The lighting control center shall conform to the following:
  1. The lighting control center shall consist of time switch electrically operated, mechanically held magnetic contactors, terminal blocks, selector switches and internal wiring.
  2. Enclosure shall be N.E.M.A. type one, wall mounted with latching facilities.
  3. Manual-off-automatic selector switch for each mode of operation shall be mounted on hinged door.
  4. The lighting control center shall be wall mounted where indicated on the Drawings.
  5. Internal circuitry of control center shall prevent exterior lighting circuits from being energized until outside illumination level falls below setting of the photo electric control device and to de-energize circuits when setting of photo electric control device is exceeded.
  6. Within limits of photo control, designated circuits shall be time controlled while other circuits are photo controlled only.

## 2.12 LUMINAIRE EFFICIENCIES

### A. HID Luminaires:

Upward Efficiency	Lamp Wattage	Closed Fixture (HC) LER	Open Fixture (HO) LER
		Recommended	Recommended
Metal Halide Lamps			
0%	150-399	41 or higher	insuff. data
	400-999	53 or higher	59 or higher
	≥1000	77 or higher	insuff. data
1%-10%	150-399	56 or higher	insuff. data
	400-999	62 or higher	64 or higher
	≥1000	insuff. data	88 or higher
>20%	150-399	62 or higher	77 or higher
	400-999	65 or higher	insuff. data
	≥1000	insuff. data	insuff. data
High Pressure Sodium Lamps			
0%	150-399	58 or higher	68 or higher
	400-999	63 or higher	84 or higher
	≥1000	insuff. data	insuff. data
1%-10%	150-399	64 or higher	63 or higher
	400-999	82 or higher	89 or higher
	≥1000	insuff. data	109 or higher

11%-20%	150-399	insuff. data	78 or higher
	400-999	insuff. data	94 or higher
	≥1000	insuff. data	insuff. data
>20%	150-399	75 or higher	77 or higher
	400-999	insuff. data	insuff. data
	≥1000	insuff. data	insuff. data

B. Downlight Luminaires:

Luminaire Type (NEMA designation)	Recommended LER
Compact Fluorescent Lamps (CFLs)	
Open Optics	29 or higher
Baffled Optics	21 or higher
Lensed Optics	24 or higher
Metal Halide Lamps	
Open Optics	35 or higher
Lensed Optics	30 or higher

C. Fluorescent Luminaires:

Luminaire Type (NEMA Designation)	Number of Lamps	Recommended LER
2' x 4' Recessed		
Lensed (FL)	2	62 or higher
	3	61 or higher
	4	61 or higher
VDT-Preferred Louvered (FP)	2	50 or higher
	3	51 or higher
	4	54 or higher
Plastic Wraparound		
Four-Foot (FW)	2	63 or higher
	4	62 or higher
Strip Lights		
Four-Foot (FS)	1	70 or higher
	2	70 or higher

Industrial		
Four-Foot (FI)	2	67 or higher
Eight-Foot (FI)	2	68 or higher
2' x 2' Recessed, for U-Tube Lamps		
VDT-Preferred	2	41 or higher
Lensed	2	49 or higher

D. Compact Fluorescent Lamps:

To Replace Incandescent Bulb Rated at	Necessary Light Output (Lumens)	Typical CFL Replacement Wattage	Recommended CFL Lumens per Watt (lpW)
Bare Bulbs			
40 watts	495 or more	11 - 14 watts	45 lpW or more
60 watts	900 or more	15 - 19 watts	60 lpW or more
75 watts	1200 or more	20 - 25 watts	60 lpW or more
100 watts	1750 or more	≥29 watts	60 lpW or more
Reflector Type Bulbs			
50 watts	550 or more	17 - 19 watts	33 lpW or more
60 watts	675 or more	20 - 21 watts	40 lpW or more
75 watts	875 or more	≥22 watts	40 lpW or more

E. Exit Sign:

1. UL listed. Provide with automatic power failure device, [test switch, pilot light, integral self-testing module] and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

Product Type	Recommended
All Fixtures	5 watts or less

## 2.13 FIBER OPTIC LIGHTING

### A. Illuminators

1. Illuminators shall utilize non-proprietary lamps available from at least 2 independent sources.
2. Lamps shall maintain minimum quality specifications based on the following chart:

Lamp Type	Lamp Life	CRI	Color Temp
250w Metal Halide	5,000 hours	86	4200K
150w Metal Halide	6,000 hours	96	4200K
100w Halogen	2,500 hours	100	3400K
75w Halogen	4,000 hours	100	3000K

3. Illuminators shall accommodate up to 1,000 fibers of 0.75mm in diameter, or up to 140 fibers of 0.75mm in diameter at minimum of 2x the lumen output.
4. Illuminators shall be forced air cooled, and capable of operating in temperatures ranging from -10°C to +40°C.
5. Illuminators must be extremely quiet, operating at a maximum of dB(A) 32 (dry/damp location,) and dB(A) 45 (wet location).
6. Illuminators shall include attached, 6' (minimum) cord with plug. (dry/damp location only).
7. Illuminators shall be clearly marked with UL or cUL approval, as well as CE listing.

### B. End Light Fiber (PMMA).

1. Stranded PMMA End Light Fiber shall be capable of indoor and outdoor use, including installation into wet locations.
2. Stranded PMMA End Light Fiber shall be jacketed in Megolon S530 sheathing compound, which must be halogen free and fire retardant.
3. Stranded PMMA End Light Fiber shall be capable of a minimum bend radius of no more than 6x the active diameter of the fiber.
4. Stranded PMMA End Light Fiber shall maintain its flexibility in temperatures as low as -40°C.

### C. End Light Fiber (Glass)

1. Stranded Glass End Light Fiber shall be capable of indoor and outdoor use, excluding installation into wet locations, except with appropriate protection to guarantee stranded fibers will not be directly exposed to contact with water.
2. Stranded Glass End Light Fiber shall be jacketed in Megolon S530 sheathing compound, which must be halogen free and fire retardant.
3. Stranded Glass End Light Fiber shall be capable of a minimum bend radius of no more than 6x the active diameter of the fiber.
4. Stranded PMMA End Light Fiber shall maintain its flexibility in temperatures as low as -40°C.

### D. 360° Radiating Side Light Fiber (PMMA).

1. Stranded PMMA Side Light Fiber shall be capable of indoor and outdoor use, including installation into wet locations.
2. Stranded PMMA Side Light Fiber shall be jacketed in a clear, flexible sheathing material containing algaecides, fungicides and UV inhibitors.
3. Stranded PMMA Side Light Fiber shall be capable of a minimum bend radius of no more than 6x the active diameter of the fiber.
4. Stranded PMMA Side Light Fiber shall maintain its flexibility in temperatures as low as -40°C.

### E. 360° Radiating Side Light Fiber (Large Core)

## LIGHTING FIXTURES AND ACCESSORIES

1. 360° Radiating Large Core Side Light Fiber shall be capable of indoor and outdoor use, excluding installation into wet locations, except with appropriate protection to guarantee fiber core will not be directly exposed to contact with water.
  2. 360° Radiating Large Core Side Light Fiber shall be jacketed in a bondable, flexible sheathing material containing algaecides, fungicides and UV inhibitors, and with a UL94VO fire rating.
  3. 360° Radiating Large Core Side Light Fiber shall be capable of a minimum bend radius of no more than 6x the active diameter of the fiber.
  4. 360° Radiating Large Core Side Light Fiber shall have a wide, 80° acceptance angle and beam spread.
- F. Directional Side Light Fiber (Large Core)
1. Directional Large Core Side Light Fiber shall be capable of indoor and outdoor use, excluding installation into wet locations, except with appropriate protection to guarantee fiber core will not be directly exposed to contact with water.
  2. Directional Large Core Side Light Fiber shall be jacketed in a bondable, flexible sheathing material containing algaecides, fungicides and UV inhibitors, and with a UL94VO fire rating.
  3. Directional Large Core Side Light Fiber shall be capable of a minimum bend radius of no more than 12x the active diameter of the fiber.
  4. Directional Large Core Side Light Fiber shall produce a 30° - 60° beam of light, with uniform output along the entire "lit" length, regardless of variations in length.
- G. Harnessing / Fiber Terminations (End Light PMMA & Glass)
1. Fibers shall be terminated into Fiber Harness (Common End) using all of the following techniques:
    - a. Randomizing: Fibers must be randomized within the harness, allowing individual strands of fiber from each fiber tail to be located at random locations across the face of the illuminator port. Randomizing technique allows each fiber tail to maintain equal brightness.
    - b. Crimping: Fiber Harness shall be compressed to allow for a minimum packing fraction with little or no air gaps in between fibers.
    - c. Fusing: Fibers shall be fused together at the tip of the harness with a minimum fuse depth of 1/8". Fusing technique allows fibers to be polished and ensures that no debris may enter the minimal air gaps in between the fibers.
    - d. Polishing: Fiber Harness shall be polished to a smooth, glass-like finish. No individual fibers shall be felt when running ones finger over the fiber surface. Polishing allows for maximum light entry into the fibers, resulting in a higher brightness than conventional fiber harnessing techniques.
  2. Fibers shall be terminated into Fixture Ferrule using all of the following techniques:
    - a. Gluing: Fibers shall be glued into Fixture Ferrule to ensure a secure connection.
    - b. Polishing: Fixture Ferrules shall be polished to a smooth, glass-like finish. Polishing allows for maximum light emission from the fibers, resulting in a higher brightness than conventional cut fiber terminations.
  3. End Light PMMA & Glass Harnessing and Fiber Terminations should be completed in the manufacturer's factory, whenever possible. Whenever factory terminations make installation of the system impossible, contact the manufacturer for on-site termination options which maintain the parameters set forth in items 2.12-H-1 and 2.12-H-2.
- H. Harnessing (Large Core)
1. Fibers shall be terminated into Fiber Harness (Common End) using all of the following techniques:
    - a. Factory Preparation: Individual fibers to be factory prepared for termination into Fiber Harness, including stripping of outer jacket of fiber, polishing of fiber end, and covering of fiber with safety cap (to be discarded in the field after routing of the fiber).
    - b. Harnessing: All fibers to be mounted into Fiber Harness according to manufacturer's instructions.



- I. Harnessing (360° Radiating Side Light PMMA)
  - 1. 360° Radiating Side Light PMMA Harnessing should be completed in the manufacturer's factory, according to the same methods set forth under section 2.12-H, whenever possible. Whenever factory terminations make installation of the system impossible, termination shall be performed according manufacturer's instructions.
- J. Fixtures (Indoor)
  - 1. Indoor Fixtures to be manufactured using high quality materials including all aluminum construction and glass optical lenses.
  - 2. All Indoor Fixtures shall accept End Light PMMA or Glass Fiber terminated into Fixture Ferrules as described in section 2.12-G-2.
- K. Fixtures (Outdoor)
  - 1. Outdoor Fixtures to be manufactured using high quality materials including all stainless steel construction and glass optical lenses.
  - 2. All Outdoor Fixtures shall accept End Light PMMA or Glass Fiber terminated into Fixture Ferrules as described in section 2.12-G-2.
- L. Fiber Array Fixtures
  - 1. All Fiber Array Fixtures to include polished fiber ends on the array surface to maximize light output.
  - 2. When mounted in outdoor applications, Fiber Array Fixtures shall include hard-anodized aluminum construction and shall be sealed with optically clear silicone to guarantee a waterproof fixture.
  - 3. Fiber tails of Fiber Array Fixtures should be terminated in the manufacturer's factory, according to the same methods set forth under section 2.12-H, whenever possible. Whenever factory terminations make installation of the system impossible, termination shall be performed according manufacturer's instructions.
- M. Photometric Information
  - 1. Manufacturer shall provide accurate photometric data for all end light fiber optic systems. Fiber optic system components, including Fiber Harness, must be capable of repeatable performance, with identical light output from system to system.
  - 2. Photometric data must be specific to each individual application and to each individual end light fixture within the application.
  - 3. Photometric data must take into consideration all factors affecting light output of fiber optic lighting systems, including lamp type and wattage, fiber type and active diameter, length of individual fiber optic cable, quantity of fiber optic cables per harness, and beam angle.
  - 4. Photometric data shall be provided upon request in IES file format for use in specifying designer's computer software programs.
- N. Installation
  - 1. Fiber optic lighting systems typically have a minimum production time of 3 – 4 weeks, excluding submittals. Contractor is responsible for ordering fiber optic lighting systems in a reasonable time frame to meet all deadlines.
  - 2. Illuminators to be installed in remote location, accessible for regular maintenance and lamp replacement.
  - 3. Illuminator location to be well ventilated with positive air flow according to manufacturer's recommendations.
  - 4. All fiber optic cable lengths to be field measured and provided to manufacturer upon order. Fiber optic cables that are ordered shorter than necessary will be rendered useless. Fiber optic cables that are ordered more than 5' longer than necessary will exhibit noticeable light loss and will be considered unacceptable.
  - 5. Fiber optic cables shall adhere to minimum bend radii shown throughout section 2.12.
  - 6. Fiber optic cables shall be continuous with no possibility of splicing to increase or extend length.
  - 7. Fiber optic fixtures shall be installed according to manufacturer recommendations.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Provide luminaires at locations, and of types, as indicated on the contract drawings.
- B. Contractor shall be responsible for coordinating with the other trades to ensure and maintain adequate recess clearance as lighting positions are critical and shall take precedence over other concealed building systems.
- C. Contractor shall be responsible for installing fixtures with proper ventilation so as not to exceed the temperature rating of the lighting fixtures or lamps.
- D. Notify the Architect about field conditions at variance with plans and/or specifications before commencing installation. Failure to do so shall exonerate the Architect from responsibility for problems resulting from same, and work required to correct the discrepancy shall be performed by the Contractor with no additional compensation.
- E. Prior to ordering lighting equipment, the Contractor shall verify locations and recess depths, final voltages, and ceiling trims compatibility. Additional charges for failure to verify locations will not be allowed.
- F. Plaster frames for recessed fixtures shall be installed in a rigid manner so as not to allow fixture frame or housing to move or shift when trim is removed or fixture is re-lamped.
- G. For bracket-mounted fixtures, provide metal plate attached to outlet box with threaded holes suitable for supporting the fixture rigidly in design position. Studs shall be steel or malleable iron, and galvanized. Die cast studs shall not be used. Electrical boxes shall be securely mounted and not move in the wall or shall be reset and wall refinished at the Contractor's expense.
- H. Where required by the local building or health department, provide approved wire guards and or plastic sleeves over fixtures.
- I. Install luminaires properly and safely. Provide hangers, rods, mounting brackets, supports, frames, yokes, support bars and other equipment required for a complete installation.
- J. Luminaires shall be complete with lamps of the type noted in the schedules and shall have metal parts, glassware, plastic diffusers etc., free from scratches, cracks, and other defects. Items damaged during shipment handling, or installation shall be replaced without expense to the Owner.
- K. Parabolic fixture care: Parabolic fixtures to be installed with Mylar cover shall be U.L. listed for temporary lighting. Upon completion of work, remove Mylar cover with white gloves and assure louvers are free from dust and fingerprints.
- L. Fixtures installed with plastic lenses shall be cleaned and de-staticized after installation. Install and leave with no fingerprints or dirt marks on the lens or diffuser. Use white gloves if necessary.
- M. Install lamps in fixtures. Lamps must be operational at time of turn over to the owner.
- N. Luminaires to be cleaned prior to opening the facility.
- O. Luminaires shall be packaged with complete instructions and illustrations showing proper installation procedures. Install luminaires in strict conformance with manufacturer's recommendation and instructions.
- P. Contractor is required to protect fixtures from damage during installation and up to time of acceptance by the Architect. Broken fixtures, glassware, plastics, lamps etc. must be replaced by the Contractor with new parts without expense to the owner.
- Q. Whenever a luminaire is operated as a work light during construction it shall be re-lamped with the project-specified lamp just prior to turnover of the area to the owner.

- R. Fixtures shall be installed so that no labels will be visible under normal operating conditions of the fixture.
- S. If fixtures are installed in a fire rated ceiling, the Contractor will preserve the fire rating according to the UL assembly number.
- T. Light poles shall be grouted to fill the space between the pole base plate and the concrete base.
- U. Ground mounted landscape lights shall be wired with ingrade junction boxes, spikes with wiring compartments, and/or "power pipes" with integral junction compartments. Fixtures mounted to junction boxes raised above ground by bare conduit are not acceptable.
- V. Metal halide lamps with a discernable color shift after 100 hours of operation shall be replaced with no additional cost to the owner.
- W. Wall slot fixtures are to be installed prior to the finishing of walls where they are found. They are to be used as the sole work light when finishing the adjacent wall.
- X. Tree mounted lighting and conduit.
  - 1. When multiple fixtures of a given voltage are mounted in trees, power shall be provided from base of tree to junction box on tree strap in tree canopy (or at base of bulb for palm trees) through single exterior grade MC cable with black coating.
  - 2. Permanent conduit will include the use of a stainless steel screw of proportionate size to penetrate the bark and enter the wood. Once the screw is in place, it is important that it not be removed, to allow the trees natural ability to compartmentalize wood to control the spread of decay.
  - 4. Screws shall be separated a minimum of 12" apart vertically. S Screws shall be staggered a minimum of 1.5" to prevent a straight vertical column. Screws shall have appropriate size and length to hold conduit to tree without pulling loose from bark.
  - 5. In Inspections of Conduit Installations will be every 6 months for fast growing species and every 1 year for slower growing species.
  - 6. If removal of conduit from a tree is required cut the head of the screw off and remove attachments. Do not remove screw from tree.
  - 7. Leave an appropriate "growth loop" in conduit to allow for growth of the tree.
  - 8. Permanent screw attachment of conduit may not be mounted on trees with less than a 12-inch caliper. Trees with caliper ranging from 6-12-inches may have conduit attached with stainless steel cable nail.
  - 9. Stainless steel bands shall be adjustable and a minimum width of 1 inch.
  - 11. A back-up cable for suspended tree lighting shall be installed around the limb, loose fitting to allow for growth, and to avoid strangulation.
  - 12. Weight bearing cable to suspend light fixtures shall have a "saddle" at the point of contact to decrease possibility of cutting into tree tissue.
  - 13. Permanent twinkle lights shall be affixed with insulated staples under the following guidelines:
    - a. Insulated staples shall be separated a minimum of 12" apart vertically.
    - b. Insulated staples shall be staggered a minimum of 0.5" to prevent a straight vertical column.
    - c. Insulated staples shall have appropriate size and length to hold conduit to tree without pulling loose from bark.
    - d. Inspections of Conduit Installations shall be every 6 months for fast growing species and every one year for slower growing species.
    - e. Inspections of Conduit Installations shall be every 6 months for fast growing species and every one year for slower growing species.
    - f. When removal of lights from a tree is required, caution must be used to not cause further damage to the cambium by tearing the staples off or damaging the cambium by prying staples off with undesignated tools.
    - g. Leave an appropriate "growth loop" in lights to allow for growth of the tree.
    - h. Insulated screws may not be mounted on trees with less than a 1-inch caliper.

- Y. Matte white face plates for pinhole and slot downlights shall be painted prior to installation to match the ceiling in which each is to be located.
- Z. Remote ballasts and transformers shall be concealed in dry, accessible locations unless otherwise directed.

### **3.2 AIMING AND ADJUSTMENTS**

- A. Adjustable lighting units shall be aimed, focused, and locked, etc., by the Contractor under the supervision of the Lighting Designer.
- B. Aiming and adjusting shall be carried out after installation is complete. Ladders and scaffolding, etc., required shall be furnished by the Contractor at the direction of the Lighting Designer. As aiming and adjusting is completed, locking setscrews, bolts, and nuts shall be tightened securely.
- C. Where possible, units shall be focused during normal working daytime hours. However, where daylighting interferes with aiming and focusing, the aiming shall be performed at night.
- D. For fixtures that have lamps with multiple beam spreads available, the contractor shall provide 150% of total lamp quantity required, with distribution broken down as follows:
  - 75% Flood
  - 75% Spot
  - 150% total

A portion of the lamps remaining after the final aiming will be turned over to the owner for stock; while the others shall be returned unopened to the contractor's distributor for full credit.

### **3.3 COORDINATION WITH AMBIENT CONDITIONS**

- A. The Contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions which will exist when the luminaires are installed. These areas of coordination include, but are not limited to, the following:
  - 1. Wet location labels.
  - 2. Damp location labels.
  - 3. Low temperature ballasts.
  - 4. Dimming ballasts.
  - 5. Very low heat rise ballasts.
  - 6. Plenums and air handling spaces.
  - 7. Fire rated ceilings.
  - 8. Low density ceiling.
  - 9. Insulated ceilings.

### **3.4 SITE ENVIRONMENTAL PROCEDURES**

- A. Resource Management:
  - 1. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.
    - a. Electronic Dimming Ballast: Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.
    - b. Occupancy Sensor: Test sensors for proper operation. Observe for light control over entire area being covered.
  - 2. Coordinate with manufacturer for [maintenance agreement] [take-back program] [green lease].

END OF SECTION

Pico Library  
Santa Monica, CA

LIGHTING FIXTURE  
SCHEDULE  
AND  
FIXTURE ILLUSTRATIONS

THE LIGHTING DESIGN  
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Initial Issue:  
2 September 2011

- Revisions:
1. 50% CD – 20 December 2011
  2. 65% CD – 20 January 2012
  3. Addendum – 21 February 2012
  4. 100% CD - 16 July 2012

**FIXTURE NOTES:**

- 1) Fixtures shall have appropriate UL label, damp, or wet as required by local codes.
- 2) Fixtures shall include accessories for installation according to local and national codes.
- 3) Prior to ordering lighting equipment, the contractor shall verify locations and recess depths.
- 4) Lamps shall be installed according to the attached fixture schedule.
- 5) Contractor shall verify final voltages and ceiling trim compatibility prior to ordering fixtures.
- 6) Ceiling thickness in excess of 3/4" shall be identified in writing by Contractor/Architect.
- 7) Fixtures shall be ordered with the appropriate ballasts that have UL and CBM labels. Ballasts shall conform to Title 24 requirements for performance, switching, and wiring (i.e. tandem).
- 8) Provide approved fire-rated enclosures for lighting fixtures located in a fire-rated ceiling.
- 9) Walls directly illuminated shall be installed and finished in a manner to eliminate shadows or blemishes (i.e. hang dry wall vertically).
- 10) Responsibility for emergency lighting, Title 24 calculations, and circuiting to meet code conformance remains with the Architect and Electrical Engineer as required by law.
- 11) LED fixtures requiring digital communication for complete functionality shall be provided with allowances for: routing and pulling required digital control wiring as per the manufacture's specification; termination of digital control wiring for signal transmission; addressing, commissioning, and verification of all LED digital controls; interface with dimming and control system or building management controls as necessary.
- 12) Fixtures located in an insulated ceiling area, shall have an IC housing (electrical contractor to coordinate).
- 13) The Architect and Lighting Designer shall approve fixture substitutions prior to bid. Contractor shall supply a sample and/or photometric data if requested. If substitution is rejected, Contractor shall provide specified product.
- 14) All fixture voltages to be determined by electrical engineer.

Latest revisions in **BOLD**

TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
BM1	Pole mounted metal halide walkway fixture	Exterior walkways	Lithonia AS1-150M-SR3-RPA-SCWA-DNA-L/LP Pole: RTA-20-5C-DNA	Philips (1) MHC150/U/MP/4K MasterColor  Or equal by GE	180	Installation to match existing post tops in Thelma Terry Parking lot in all respects. Rotate optics to match direction as shown in plans.	
DT1	<del>Table lamps permanently mounted on tables</del> <b>FIXTURE NO LONGER USED</b>	<b>Desks</b>	<del>Louis Poulsen</del> <del>AJ-T</del>	<del>Philips</del> <del>(1)</del> <del>A-19/IF Medium</del>	<b>60</b>		<b>4</b>
DT2	Surface mounted warm white 3000K linear LED <del>single double</del> rail table lamp permanently mounted on tables	Eastern reading areas	Vode <b>517-RR-L28-SA-30-A</b>	Warm White LEDs included	16.8w	<b>Provide fixture with a-b switching to control each rail individually.</b>	<b>4</b>
DT2a	Surface mounted warm white 3000K linear LED <del>double single</del> rail table lamp permanently mounted on tables	Reading desks	Vode <b>507-RR-L07-SA-30-A</b>	Warm White LEDs included	3.4w		<b>4</b>
FF1	Surface mounted 28 watt linear T5 fluorescent 4" by 4' rectangular wet labeled downlight with acrylic lens	<del>Canopies</del> <b>Arbor</b>	Axis Lighting WBS-F-4-T5-1-FINISH-volts-ERS-1-SC-TF	Philips (1) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	28		

TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
GD1	In-grade recessed warm white 2900K LED uplight with 10.3" round aperture, 20 degree adjustability, and medium beam distribution	Exterior Signage	Lumascap LS853LED-20H6-A-M-82-M-29-Q-volts	Warm White LEDs included	20	Fixture to be installed in concrete block out. Provide with LS6052-K-SP pre-installation kit.	3
JD1	Spike mounted warm white LED tree uplight	Landscape	Lumiere Cambria 203 Series	Warm White LEDs included	Allow 30		
JD2	Surface mounted wet location with warm white LED <b>downlights</b> to highlight fabric canopies	Exterior fabric canopies	Lumenpulse LBM-VOLTS-30K-FL-BK-DIM	Warm White LEDs included	27	Dimmable via 0-10 volt control.	4
PC1	Pendant mounted 26 watt compact fluorescent decorative chandelier, with Lutron Ecosystem dimmable ballast	Seating Areas	Lightolier PM Series PM32MX1SA-PG01-SK01	Philips (1) PL-C 26W/830/ALTO  Or equal by: GE, Sylvania	26	Dimmable via Lutron Ecosystem and on photocell control.	
PF1	Pendant mounted 28 watt linear T5 fluorescent striplight with chain mounting and wire guard	Support Spaces	Lightolier SV-4-S-1-28-UNV-PG-SV5GXW4	Philips (1) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	28		
RD1	Recessed 1500 lumen 3000k warm white LED downlight with 4" round aperture	Throughout	Lightolier Frame-in Kit: C6L15-N-volts	Warm white LED included	27		2
RD2	Recessed 400 lumen 3000k warm white LED downlight with small 2" round aperture and wet labeled downlight with painted white trim	<del>Entry ceilings</del> <b>Exterior Soffit</b>	Lightolier Frame-in Kit: C2L04DL-30K-17-R-1  Reflector: CL2-DL-WH-P	Warm white LED included	10		4
RD3	Recessed 1500 lumen 3000k warm white LED downlight with 4" round aperture and glass trim	Throughout	Lightolier Decorative Trim: D6A01  Frame-in Kit: C6L15-N-volts	Warm white LED included	27		2

TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
RF1	NO LONGER USED	<del>Group Study Rooms</del>	<del>Lightolier SN-3-S-1-21-HPF- volts-Lutron H- Series Ecosystem ballast</del>	<del>Philips (1) F21T5/ADV830/ ALTO  Or equal by: GE, Sylvania</del>	<del>21</del>	<del>Contractor to verify length of fixture on sight. Dimmable via Lutron H- Series Ecosystem and on photocell control.</del>	<del>2</del>
RF2	Recessed 28 watt linear T5 fluorescent 4" by 4' downlight with acrylic lens	IT and Back of house areas	Lightolier CT3-F-P-A-S-4-U- volts	Philips (1) F28T5/ADV830/ ALTO  Or equal by: GE, Sylvania	28		2
RF3	Recessed 28 watt linear T5 fluorescent 4" by 4' wet label downlight with acrylic lens	Exterior Soffit	Axis Lighting WBR-F-4-T5-1-W- volts-ERS-1-TF	Philips (1) F28T5/ADV830/ ALTO  Or equal by: GE, Sylvania	28		
RZ1	Recessed (2) lamp 28 watt linear T5 fluorescent downlight with (2) Adjustable warm white LED accent lights	Throughout	Pinnacle Edge EX4	Philips Linear Fluorescent: (2) F28T5/ADV830/ ALTO  Or equal by: GE, Sylvania  LED Downlight: Warm white LEDs included	Allow 96	Dimmable via Lutron H Series Ecosystem for fluorescent lighting and Ecosystem driver for LED downlights. Fluorescent and downlight fixtures on separate circuits, and individually controlled.	2
RZ1a	Same as RZ1 but with 3' linear T5 fluorescent downlight	Workroom	Pinnacle Edge EX4	Philips Linear Fluorescent: (2) F21T5/ADV830/ ALTO  Or equal by: GE, Sylvania  LED Downlight: Warm white LEDs included	Allow 82	Dimmable via Lutron H Series Ecosystem for fluorescent lighting and Ecosystem driver for LED downlights. Fluorescent and downlight fixtures on separate circuits, and individually controlled.	2
SD1	Surface mounted warm white linear LED striplight with clear lens suitable for exterior applications	Book Drop-off	Tivoli Lighting LED Strip: TBL-O-WWH-2-MD- 12-PSU  Mounting Accessory: TPL-TUBE-C-length	Warm white LED included	1.15w/ft	Contractor to provide all necessary wiring accessories as needed. Contractor to verify length on site.	3



TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
SD2	Surface mounted warm white linear LED striplight with frosted lens suitable for exterior applications	<b>Amphitheater seating</b>	Tivoli Lighting  LED Strip: TBL-O-WWH-2-MD-12-PSU  Mounting Accessory: TPL-TUBE-F-length	Warm white LED included	1.15w/ft	Contractor to provide all necessary wiring accessories as needed. Contractor to verify length on site.	4
SF1	Surface mounted low profile 4'-0" T5 fluorescent striplight within cove with Lutron Ecosystem dimmable ballast	<b>Skylights Group Study Rooms</b>	Lightolier  SN-4-S-1-28-HPF-volts- Lutron H-Series Ecosystem ballast	Philips  (1) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	Allow 7w/ft.	Dimmable via Lutron H-Series Ecosystem and on photocell control.	4
SF1a	Surface mounted 3'-0" 21 watt linear T5 fluorescent striplight within cove with Lutron Ecosystem dimmable ballast	Group Study Rooms	Lightolier  SN-3-S-1-21-HPF-volts- Lutron H-Series Ecosystem ballast	Philips  (1) F21T5/ADV830/ALTO  Or equal by: GE, Sylvania	21	Contractor to verify length of fixture on sight. Dimmable via Lutron H-Series Ecosystem and on photocell control.	2
SF2	Surface mounted 28watt T5 fluorescent under cabinet striplight	<b>Staff Room and Lounge</b>	HE Williams  1SF-4-128T5S-A12125-EB1-volts	Philips  (1) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	Allow 7w/ft.		4
WC1	Wall mounted (2) lamp 26 watt compact fluorescent vanity light	Restroom	Louis Poulsen  AJE-17.7-2/26/CF-volts-WHT-WALL	Philips  (2) PL-C 26W/830/ALTO  Or equal by: GE, Sylvania	42	<b>Fixture to be mounted at 5'6" AFF</b>	4
WD1	Wall mounted warm white LED floodlights	Community room exterior Wall	Lumenpulse  LBM-volts-30K-FL-BK-DIM	Warm white LED included	Allow 40	Dimmable via 0-10 volt control.	
WD2	Wall recessed LED step light with 12.5" by 2.75" rectangular aperture	Landscape Steps	Bega  2384LED	Warm white LED included	10		
WD3	Wall recessed 1000 lumen 3000k warm white LED accent light with spot reflector with 8 1/2" by 7 5/8" rectangular aperture with white powder coat 3/4" trim and double gimbal ring	Community Room <b>Skylight</b>	Architectural Lighting Works  RCST-1-XC8030-1000-H-INT-S-volts-WH-SOL	Warm White LEDs included	15	Fixture mounted within the vertical wall within the community room skylight. Provide with diffuse Solite Lens Dimmable via 0-10 volt control.	4

TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
WF1	Stack mounted 28 watt linear T5 fluorescent 4' stack light with low profile asymmetric distribution with Lutron Ecosystem dimmable ballast	Stacks	Vode Lighting WG-K1-4C-ST-24-IB-B-volts-0-HE-A-1-2-Lutron Ecosystem ballast	Philips (1) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	28	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
WF1a	Same as WF1 but with 3' fixture length	Stacks	Vode Lighting WG-K1-3C-ST-24-IB-B-volts-0-HE-A-1-2- Lutron Ecosystem ballast	Philips (1) F21T5/ADV830/ALTO  Or equal by: GE, Sylvania	21	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
WF2	Stack mounted (2) 28 watt linear T5 fluorescent 4' stack light with low profile asymmetric distribution with Lutron Ecosystem dimmable ballast	Stacks	Vode Lighting WG-K2-4C-ST-24-IB-B-volts-0-HE-A-1-2- Lutron Ecosystem ballast	Philips (2) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	54	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
WF2a	Same as WF2 but with 3' fixture length	Stacks	Vode Lighting WG-K2-3C-ST-24-IB-B-volts-0-HE3-A-1-2- Lutron Ecosystem ballast	Philips (2) F21T5/ADV830/ALTO  Or equal by: GE, Sylvania	42	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
WF3	Stack mounted 28 watt linear T5 fluorescent 4' stack light with low profile asymmetric distribution mounted on custom 15" vertical strut system with Lutron Ecosystem dimmable ballast	Lower Stacks	Vode Lighting Fixture: WG-K2-4C-ST-24-IB-B-volts-0-HE-A-1-2- Lutron Ecosystem ballast  Strut: To be determined	Philips (2) F28T5/ADV830/ALTO  Or equal by: GE, Sylvania	54	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be mounted on a 15" vertical strut system provided by Vode. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
WF3a	Same as WF3 but with 3' fixture length	Lower Stacks	Vode Lighting Fixture: WG-K2-3C-ST-24-IB-B-volts-0-HE3-A-1-2- Lutron Ecosystem ballast  Strut: To be determined	Philips (2) F21T5/ADV830/ALTO  Or equal by: GE, Sylvania	42	Dimmable via Lutron H-Series Ecosystem and photocell control. Fixture to be mounted on a 15" vertical strut system provided by Vode. Fixture to be cantilevered out 12" inches from the face of the stacks.	2
CDS1	Wireless daylight sensor located at ceiling plane as part of CWS1	Throughout	Lutron LRFX-DCRB	NA	NA	Allow for (8) sensors.	2

TYPE	DESCRIPTION	LOCATION	MANUFACTURER & CATALOG #	NUMBER OF LAMPS & TYPE	TOTAL WATTS	REMARKS	REV #
CWS1	Wall recessed Ecosystems Grafik Eye room controller and dimmer with 4 scene preset and integral astronomical time clock connected to daylight sensors	Throughout	Lutron  GRAFIK EYE QS with Ecosystem	NA	NA	Quantity to be determined based of total number of zones. Allow for (2) 16 zone Grafik Eyes.	2
CWS2	Wall recessed 2-button with raise/lower switch	Throughout	Lutron  2BLR	NA	NA	Allow for (2) switches.	2

End of Fixture Schedule

# AS AST

Aeris™



## Intended Use

For streets, walkways, parking lots and surrounding areas.

## Construction

Housing: Rugged, die-cast, single-piece aluminum housing with nominal 1/8" wall thickness.

Door Assembly: Die-cast doorframe, impact-resistant, tempered glass lens, 3/16" thick, fully sealed with one-piece tubular silicone gasket.

Finish: Standard finish is dark bronze polyester powder finish. Additional architectural colors available; see [www.lithonia.com/archcolors](http://www.lithonia.com/archcolors).

## Optics

Anodized segmented reflectors for superior uniformity and control. Reflectors attach

with tool-less fasteners and are rotatable and interchangeable. Four full cutoff distributions available: Type II (roadway), Type III (asymmetric), Type IV (forward throw), and Type V (symmetric square).

## Electrical

Ballasts: Mounted on removable power tray and have positive locking disconnect plugs. All ballasts are 100% factory tested. High reactance, high power factor for 150W and below. Constant wattage autotransformer 175W and above. MH: 150W and below are standard with pulse-start ignitor technology. Super CWA Pulse Start ballasts, 88% efficient and EISA legislation compliant, are required for 151-400W

(must order SCWA option) for U.S. shipments only. CSA, NOM or INTL required for probe start shipments outside the U.S. Compact fluorescent uses an electronic high-frequency ballast.

Socket: Porcelain, medium-base socket for AS1, mogul-base socket for AS2, with copper alloy nickel-plated screw shell and center contact. Ceramic metal halide lamps are recommended for use in applications where superior color rendition, lumen maintenance and longer lamp life are desired. Fluorescent is four-pin positive latching thermoplastic. LPI is standard 35K for CFL.

## Installation

Heavy-duty easy-mount block attaches to pole or wall to provide ease of installation as well as ensured alignment and leveling. Additional backing plate and receiver used to mount AST suspend tension rod. AST1 mounts 9.64" lower than specified pole height. AST2 mounts 13.89" lower than specified pole height.

## Listings

UL Listed (standard). CSA Certified or NOM Certified (see Options). UL Listed for 25 °C ambient and wet locations. U.S. Patent No. D447,590. Canadian Patent No. 94324. IP65 Rated.



**Pulse Start**  
HID Ballast/Lamp Systems



LIGHTING DESIGN ALLIANCE

## ORDERING INFORMATION

For shortest lead times, configure products using **bolded options**.

Example: AS1 150M SR2 TB SPA LPI

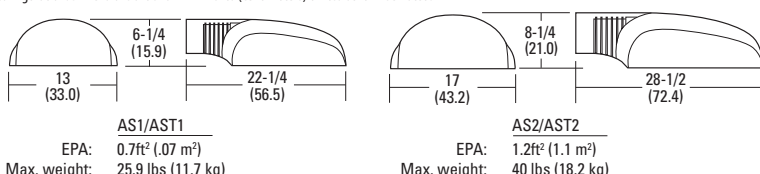
Series	Lamp type <sup>1</sup>		Distribution <sup>1</sup>	Voltage	Ballast	Mounting <sup>14</sup>	
AS1	High pressure sodium <sup>2</sup>	400S	<b>250M</b>	<b>Compact fluorescent</b>	<b>SR2</b>	Type II segmented	<b>120</b>
AS2	35S <sup>3</sup>	<b>Metal halide</b>	320M <sup>7</sup>	2/32TRT <sup>9</sup>	<b>SR3</b>	Type III segmented	<b>208<sup>10</sup></b>
AST1	50S <sup>4</sup>	50M <sup>2,5</sup>	<b>400M</b>	42 TRT	<b>SR4SC</b>	Type IV segmented, FT, sharp cutoff	<b>240<sup>10</sup></b>
AST2	70S	70M <sup>2,5</sup>	<b>Metal halide ceramic<sup>8</sup></b>	2/42TRT <sup>9</sup>	<b>SR4W</b>	Type IV segmented, FT, wide	<b>277</b>
	100S	100M <sup>2</sup>	50MHC <sup>2,5</sup>	57TRT	<b>SR5S</b>	Type V segmented, square	<b>347</b>
	150S	<b>150M</b>	70MHC <sup>2,5</sup>	70TRT			<b>480<sup>10</sup></b>
	200S	<b>175M<sup>6</sup></b>	100MHC <sup>2</sup>				<b>TB<sup>11</sup></b>
	250S	200M <sup>7</sup>	150MHC				<b>23050HZ<sup>12</sup></b>
							<b>MVOLT<sup>13</sup></b>
<b>Options</b>							
<b>Ships installed</b>				<b>Ships separately<sup>16</sup></b>			
SF	Single fuse, 120V, 277V, 347V <sup>18</sup>	PER	NEMA twist-lock receptacle only <sup>20</sup>	PE1	NEMA twist-lock PE (120V-240V)	<b>(blank)</b>	Dark bronze (std.)
DF	Double fuse, 208V, 240V, 480V <sup>18</sup>	HS	House-side shield <sup>21</sup>	PE3	NEMA twist-lock PE (347V)	<b>DBL</b>	Black
GMF	Internal slow-blow fusing	CSA	Meets Canadian standards	PE4	NEMA twist-lock PE (480V)	DGC	Charcoal gray
ELDW	Bodine emergency battery backup <sup>18</sup>	NOM	Meets Mexican standards (consult factory)	PE7	NEMA twist-lock PE (277V)	DMB	Medium bronze
EC	Emergency circuit <sup>18, 19</sup>	INTL	Available for MH probe start shipping outside the U.S.	SC	Shorting cap for PER option	<b>DNA</b>	Natural aluminum
QRS	Quartz restrike system <sup>18, 19</sup>			VG	Vandal guard <sup>22</sup>	<b>DWH</b>	White
<b>Finish</b>				<b>Lamped</b>			
				<b>LPI</b>			Lamp included
				<b>L/LP</b>			Less lamp

## ADDITIONAL INFORMATION

For additional product information, visit [www.lithonia.com](http://www.lithonia.com).

CONFIGURATIONS			DRILLING PATTERNS	
SERIES	LAMP TYPE	DISTRIBUTION	(SEE POLE ORDERING, PAGE 588)	
AS1, AST1	35S, 50S, 50M, 50MHC, 70S, 70M, 70MHC, 100S, 100M, 100MHC, 150S, 150M, 150MHC, 175M, 42TRT, 57TRT, 70TRT	SR2, SR3, SR4SC, SR5S	DM19AS	1 at 90°
AS1, AST1	2/32TRT, 2/42TRT	SR3	DM28AS	2 at 180°
AS2, AST2	175M, 200S, 200M, 250S, 250M, 320M, 350M, 400S, 400M	SR2, SR3, SR4SC, SR4W, SR5S	DM29AS	2 at 90°
			DM39AS	3 at 90°
			DM49AS	4 at 90°
			DM32AS	3 at 120° (round poles only)

Drawings are for dimensional detail only and may not represent actual mechanical configuration. Dimensions are shown in inches (centimeters) unless otherwise noted.



## Notes

- Specify lamp type and distribution. See Configurations table.
- Not available with SCWA.
- 120V only.
- 120V and 277V only.
- Not available with 480V.
- Not available AS1/AST1 SCWA.
- Must be ordered with SCWA.
- Not applicable with L/LP.
- Available in SR3 only.
- Must specify CWI for use in Canada.
- Optional multi-tap ballast (120V, 208V, 240V, 277V). In Canada 120V, 277V, 347V; ships as 120V/347V.
- Consult factory for available wattages.
- Multi-volt electronic ballast (compact fluorescent only) capable of operating on any line voltage between 120V and 277V.
- Mounting block included standard.
- Mounted in lens up orientation, fixture is damp location rated. AST available in down orientation only.
- May be ordered as accessory. Not available with AST.
- Must specify finish.
- SF, DF, QRS, EC, or ELDW options cannot be ordered together.
- Maximum allowable wattage lamp included.
- Photocell not included.
- SR2, SR3, SR4W only.
- Prefix with fixture name and size (e.g., AS1VG).

**LITHONIA LIGHTING**

1-800-279-8041 | [www.lithonia.com](http://www.lithonia.com)

PSG10

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LIGHTING CATALOG PAGE

THE LIGHTING DESIGN ALLIANCE, INC.

LOS ANGELES  
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LONG BEACH, CA 90806-2213

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[www.LightingDesignAlliance.com](http://www.LightingDesignAlliance.com)

TYPE  
**BM1**  
1 of 1



## FEATURES & SPECIFICATIONS

**INTENDED USE** — Round tapered aluminum general purpose pole for up to 50 foot mounting heights.

**CONSTRUCTION** — Spun-tapered seamless 6063 alloy aluminum tubing, heat-treated to produce a T6 temper. Circumferential satin-brushed finish. The shaft is cone-tapered to the butt diameter.

Anchor base: Cast from A356 alloy aluminum, the anchor base is heat-treated to a T6 condition. The anchor base telescopes the pole shaft and is circumferentially welded top and bottom. The anchor bases is provided with slotted holes.

Hand hole: A nominal 3" x 5" or 4" x 6" reinforced flush-covered handhole is centered 18" above the base.

Hardware: Stainless steel.

Top cap: Removable top cap provided with drill-mount poles.

Bolt covers: A356 nut covers are included with anchor base unless otherwise specified. 3RTA poles include spun aluminum base cover.

Finish: Must specify finish.

Grounding: Provision located inside hand hole rim. Grounding hardware is not included (provided by others).

Anchor bolts: Made of steel rod having a minimum yield strength of 55,000 psi. Top portion of anchor blot is galvanized per ASTM A-153. Each anchor bolt is furnished with two hex nuts and two flat washers.

Note: Specifications subject to change without notice.

Actual performance may differ as a result of end-user environment and application.

Catalog Number
Notes
Type

Anchor Base Poles

# RTA/3RTA

ROUND TAPERED ALUMINUM  
3-BOLT ROUND TAPERED ALUMINUM

### ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: RTA 25 6E DM19 BA

RTA Series	Nominal fixture mounting height	Nominal shaft base size/wall thickness	Mounting <sup>1</sup>	Options	Finish <sup>12</sup>
RTA 3RTA	20 – 50 feet (See back page.)	(See back page.)	<u>Tenon mounting</u> PT Open top T20 2-3/8" O.D. (2" NPS) T25 2-7/8" O.D. (2-1/2" NPS) T30 3-1/2" O.D. (3" NPS) <sup>2</sup> T35 4" O.D. (3-1/2" NPS) <sup>2,3</sup> <u>Drill mounting<sup>4,9</sup></u> DM19 1 at 90° DM28 2 at 180° DM28PL 2 at 180° with one side plugged DM29 2 at 90° DM32 2 at 120° DM39 3 at 90° DM49 4 at 90° <u>CSX/DSX/AERIS™/OMERO™ Drill mounting<sup>4</sup></u> DM19AS 1 at 90° DM28AS 2 at 180° DM29AS 2 at 90° DM32AS 3 at 120° DM39AS 3 at 90° DM49AS 4 at 90° <u>AERIS™ Suspend drill mounting<sup>4,8</sup></u> DMxxAST_ <u>OMERO™ Suspend drill mounting<sup>4,8</sup></u> DMxxMRT_	<u>Shipped installed</u> L/AB Less anchor bolts FBC Full base cover VD Vibration damper TP Tamper proof H1-18Axx Horizontal arm bracket (1 fixture) <sup>5,6</sup> FDLxx Festoon outlet less electrical <sup>5</sup> CPL12xx 1/2" coupling <sup>5</sup> CPL34xx 3/4" coupling <sup>5</sup> CPL1xx 1" coupling <sup>5</sup> NPL12xx 1/2" threaded nipple <sup>5</sup> NPL34xx 3/4" threaded nipple <sup>5</sup> NPL1xx 1" threaded nipple <sup>5</sup> EHHxx Extra handhole <sup>5,7</sup> MAEX Match existing <sup>10</sup> USPOM United States point of manufacture <sup>11</sup>	<u>Standard colors</u> DDB Dark bronze DWH White DBL Black DMB Medium bronze DNA Natural aluminum BA Brushed aluminum <u>Classic colors</u> DSS Sandstone DGC Charcoal gray DTG Tennis green DBR Bright red DSB Steel blue <u>Class 1 architectural anodized</u> ABL Black ADB Dark bronze ANA Natural <u>Architectural colors (powder finish)<sup>12</sup></u>

#### NOTES:

- When ordering tenon mounting and drill mounting for the same pole, follow this example: DM28/T20. The combination includes a required extra handhole.
- N/A with 4C, 5C, 5E and 5G because pole top is too small.
- N/A with 6E, 6G and 7E because pole top is too small.
- The drilling template to be used for a particular luminaire depends on the luminaire that is used. Refer to the Technical Data Section on [www.lithonia.com](http://www.lithonia.com) for Drilling Templates.
- Specify location and orientation when ordering option.  
For 1st x specify the height in feet above base of pole.  
Example: 5ft = 5 and 20ft = 20  
For 2nd x, specify orientation from handhole (A,B,C,D)  
Refer to the Handhole Orientation diagram on page 577 in PSG9.
- Horizontal arm is 18" x 2-3/8" O.D. standard.
- Combination of tenon-top and drill mount includes extra handhole.
- Insert "1" or "2" to designate fixture size; e.g. DM19AST2.
- First drilling on 3RTA poles is located directly above anchor bolt axis.
- Must add original order number.
- Use when mill certifications are required.
- Finish must be specified. Additional colors available; see [www.lithonia.com/archcolors](http://www.lithonia.com/archcolors) or Architectural Colors brochure (Form No. 794.3).

#### IMPORTANT INSTALLATION NOTES:

- Do not** erect poles without having fixtures installed.
- Factory-supplied templates must be used when setting anchor bolts. Lithonia will not accept claim for incorrect anchorage placement due to failure to use factory template.
- If poles are stored outside, all protective wrapping must be removed immediately upon delivery to prevent finish damage.
- Lithonia Lighting is not responsible for the foundation design.

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P011 F-RTA-3RTA

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LIGHTING CATALOG PAGE

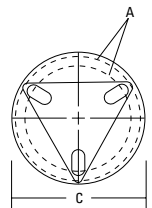
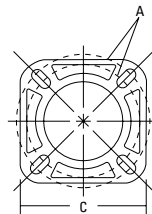
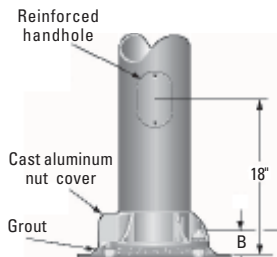
THE LIGHTING DESIGN ALLIANCE, INC.

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[www.LightingDesignAlliance.com](http://www.LightingDesignAlliance.com)

TYPE  
**BM1 Pole**  
1 of 2

TECHNICAL INFORMATION										
Catalog Number	Nominal shaft length (ft.)	Wall pole shaft size (in. x in. x ft.)	Thickness (in.)	EPA (ft <sup>2</sup> ) with 1.3 gust			Max. weight	Bolt circle (in.)	Bolt size (in. x in. x in.)	Approximate ship weight (pounds)
				80 mph	90 mph	100 mph				
RTA 20 5C	20	5 x 3 x 19.66	0.125	3.9	2.5	1.6	100	7.5-9.5	.75 x 18 x 3	62
RTA 20 5G	20	5 x 3 x 19.66	0.188	7.4	5.2	3.8	100	7.5-9.5	.75 x 18 x 3	72
RTA 20 6G	20	6 x 4 x 19.66	0.188	12.2	9.2	7.2	214	9-10	.75 x 30 x 3	107
RTA 20 7E	20	7 x 4 x 19.66	0.156	15.0	11.4	9.0	256	9.875-11.25	1 x 36 x 4	103
RTA 25 6E	25	6 x 4 x 24.66	0.156	5.3	3.6	2.6	114	9-10	.75 x 30 x 3	106
RTA 25 7E	25	7 x 4 x 24.66	0.156	9.5	7.0	5.4	162	9.875-11.25	1 x 36 x 4	120
RTA 25 8E	25	8 x 4.5 x 24.66	0.156	14.2	10.9	8.5	220	11-12	1 x 36 x 4	130
RTA 25 8G	25	8 x 4.5 x 24.66	0.188	18.0	13.8	10.9	261	11-12	1 x 36 x 4	153
RTA 30 7E	30	7 x 4 x 29.66	0.156	5.5	3.8	2.7	111	9.875-11.25	1 x 36 x 4	135
RTA 30 8E	30	8 x 4.5 x 29.66	0.156	9.4	7.0	5.3	151	11-12	1 x 36 x 4	150
RTA 30 8G	30	8 x 4.5 x 29.66	0.188	12.4	9.4	7.3	179	11-12	1 x 36 x 4	175
RTA 30 10G	30	10 x 6 x 29.66	0.188	23.8	18.3	14.3	377	14-15	1 x 40 x 4	235
RTA 35 8E	35	8 x 4.5 x 34.66	0.156	5.8	4.1	2.9	119	11-12	1 x 36 x 4	185
RTA 35 8G	35	8 x 4.5 x 34.66	0.188	8.3	6.0	4.5	141	11-12	1 x 36 x 4	220
RTA 35 8J	35	8 x 4.5 x 34.66	0.250	12.9	9.7	7.5	183	11-12	1 x 36 x 4	251
RTA 35 10G	35	10 x 6 x 34.66	0.188	17.9	13.6	10.4	295	14-15	1 x 40 x 4	268
RTA 39 8G	39	8 x 4.5 x 38.66	0.188	5.6	3.9	2.7	122	11-12	1 x 36 x 4	250
RTA 39 8J	39	8 x 4.5 x 38.66	0.250	9.7	7.1	5.4	158	11-12	1 x 36 x 4	280
RTA 39 10G	39	10 x 6 x 38.66	0.188	14.2	10.5	7.8	253	14-15	1 x 40 x 4	295
RTA 39 10J	39	10 x 6 x 38.66	0.250	20.4	15.5	11.9	300	14-15	1.25 x 48 x 5	373
RTA 50 10J	50	10 x 6 x 49.66	0.250	12.5	9.1	6.5	300	14-15	1.25 x 48 x 5	447
3RTA 8 4C	8	4 x 3 x 8	0.125	12.1	9.3	7.3	75	6.5-7.25	.75 x 18 x 3	23
3RTA 10 4C	10	4 x 3 x 10	0.125	8.8	6.7	5.2	75	6.5-7.25	.75 x 18 x 3	27
3RTA 12 4C	12	4 x 3 x 12	0.125	6.6	4.8	3.6	75	6.5-7.25	.75 x 18 x 3	31
3RTA 14 4C	14	4 x 3 x 14	0.125	4.9	3.4	2.4	75	6.5-7.25	.75 x 18 x 3	34
3RTA 16 4C	16	4 x 3 x 16	0.125	3.5	2.3	1.5	75	6.5-7.25	.75 x 18 x 3	38
3RTA 16 5C	16	5 x 3 x 16	0.125	6.9	5.0	3.8	75	7.5-8.5	.75 x 18 x 3	43
3RTA 18 5C	18	5 x 3 x 18	0.125	5.0	3.5	2.5	150	7.5-8.5	.75 x 18 x 3	47
3RTA 18 5E	18	5 x 3 x 18	0.156	7.0	5.0	3.7	150	7.5-8.5	.75 x 18 x 3	57
3RTA 20 5C	20	5 x 3 x 20	0.125	3.8	2.5	1.6	150	7.5-8.5	.75 x 18 x 3	50
3RTA 20 5E	20	5 x 3 x 20	0.156	5.5	3.8	2.6	150	7.5-8.5	.75 x 18 x 3	62



**IMPORTANT:**  
These specifications are intended for general purposes only. Lithonia reserves the right to change material or design, without prior notice, in a continuing effort to upgrade its products.

Pole Data						
	Shaft base size	Bolt circle A	Bolt projection B	Base square C	Template number	Anchor bolt description
4-Bolt Base	5"	7.50"-9.50"	3.25"	9.25"	ABTEMPLATE PJ50032	AB18-0
	6"	9"-10"	3.50"	10"	ABTEMPLATE PJ50033	AB30-0
	7"	9.875"-11.25"	4.125"	10.50"	ABTEMPLATE PJ50034	AB36-0
	8"	11-12"	4.25"	11.50"	ABTEMPLATE PJ50035	AB36-0
	10"G	14"-15"	4.50"	14.50"	ABTEMPLATE PJ50036	AB40-0
	10"J	14"-15"	5.00"	14.50"	ABTEMPLATE PJ50063	AB48-0
3-Bolt Base	4"	6.50"-7.25"	3.25"	8.875"	ABTEMPLATE PJ50128	AB18-0
	5"	7.50"-8.50"	3.25"	10.25"	ABTEMPLATE PJ50129	AB18-0



POLE-RTA-3RTA



**Est**



**Address:** 1000 University Ave., Suite 100, San Francisco, CA 94133  
**Phone:** (415) 774-1000  
**Fax:** (415) 774-1001  
**Website:** <http://www.earthlink.net/~earthlink>

## Design

## Answer problems

**Excerpt**

A) Table creates direct and angled illumination. The lighting characteristics make it suitable when placed in a situation where direct and angled illumination is required.

## Finishes

Blue/cream, yellow/cream, petalwhite, red or mar. black, eggshell grey or white, wet painted

continued

**Base:** Hot Gal zinc. **Finish:** Spray steel. **Start:** Steel

\_\_\_\_\_

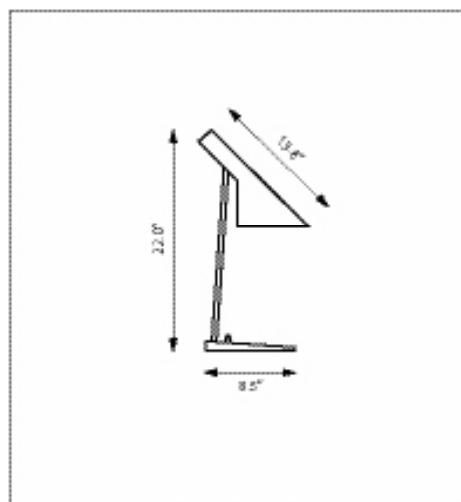
**Coat type:** Black. Dand length: 18". Switch: On/off switch located in the base.

**Keywords:**

Mar. 6 Mon.

U

cdl, Dry location. 8:30.



Product and s	Light source	Voltage	Finish
A4-T	1/40W A-T02/1E standard	120V	BLUE/GREEN YELLOW/GREEN PETERLEIGH RED SAND BLUE GREEN/GRAY WHITE

### Introduction

1. Has comparable EF version for the following classification: Export Product Code: 8225.



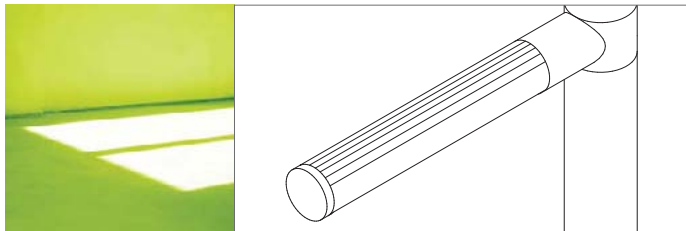




500 Series  
**Desk Light**  
VodeRail T5 & LED

500 Series | Specification Guide

LIGHTING DESIGN ALLIANCE



**500 Series Desk Light** for T5HE fluorescent and LED. Portable design in RaceRail profile. On/off switch. Brushed aluminum finish standard. For complete details, see specification guides at [vode.com](http://vode.com)



RaceRail



RaceRail

[www.vode.com](http://www.vode.com)

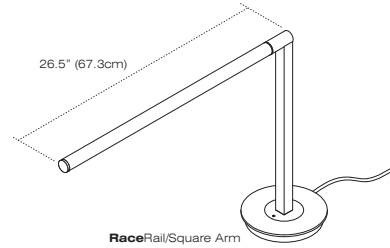
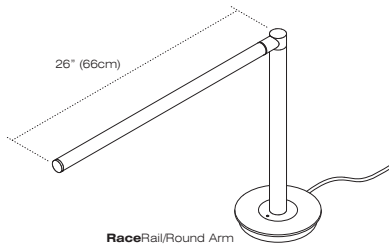
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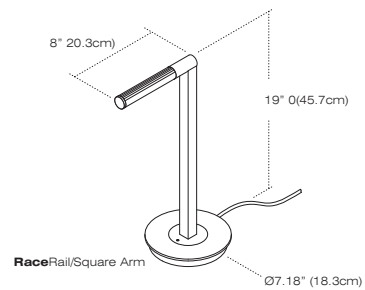
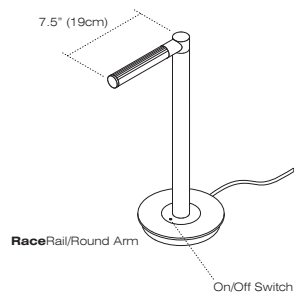
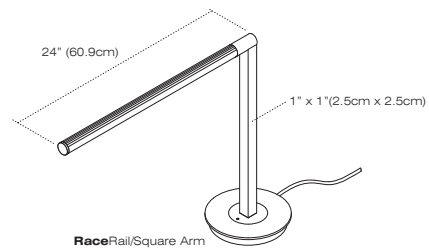
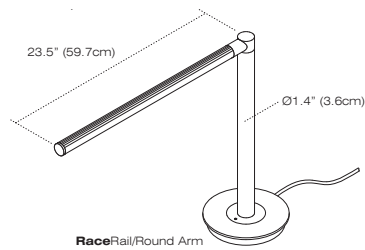


500 Series  
**Desk Light**  
VodeRail T5 & LED - Single Rail Examples

**VodeRail/T5**



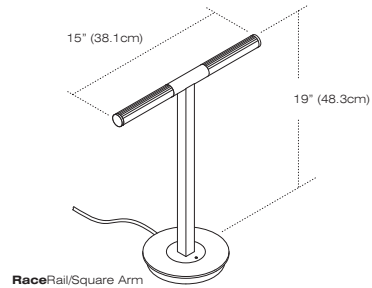
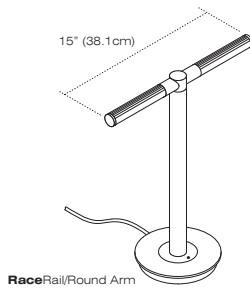
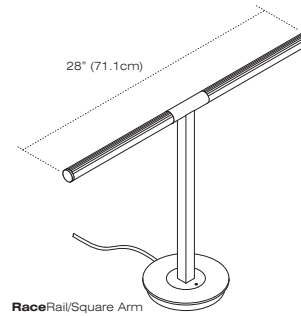
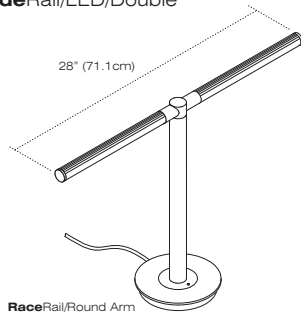
**VodeRail/LED**





500 Series  
**Desk Light**  
VodeRail T5 & LED - Double Rail Examples

VodeRail/LED/Double

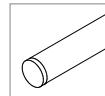




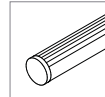
500 Series  
**Desk Light**  
**VodeRail T5 & LED** - Specification Sheet

Specification Code	Vode Code	Rail Type	Rail Length	Arm Type	Color Temperature	Finish
	505 507 517	RR	3	4	5	6

1	<b>Vode Code</b> <b>505</b> single rail T5 <b>507</b> single rail, LED <b>517</b> double rail, LED
2	<b>Rail Type</b> <b>RR RaceRail</b>
3	<b>Rail Length</b> <b>T5 Single Rail</b> <b>T26</b> 26" (66cm)  <b>LED Single Rail</b> <b>L07</b> 7.5" (19cm) <b>L22</b> 23.5" (59.7cm)  <b>LED Double Rail</b> <b>L14</b> 15" (38.1cm) <b>L28</b> 28" (71.1cm)
4	<b>Arm Type</b> <b>RA</b> round arm <b>SA</b> square arm
5	<b>Color Temperature</b> <b>30</b> warm white - 3000K <b>35</b> neutral white - 3500K <b>41</b> neutral white - 4100K
6	<b>Finish</b> <b>A</b> brushed aluminum (standard) <b>BL</b> black anodized
	<b>Technical Data</b> <b>T5</b> (lamp included) input voltage 120v wattage 14w  <b>LED</b> input voltage 120v wattage (dependent on rail length) <b>L07</b> 3.4w <b>L22</b> 16.8w <b>L14</b> 6.8w <b>L28</b> 16.8w



RaceRail/T5



RaceRail/LED

Due to rapid advancements in LED technology including optics and power configurations for LED, we recommend a visit to [vode.com](http://vode.com) for the latest LED specifications and innovations from Vode.

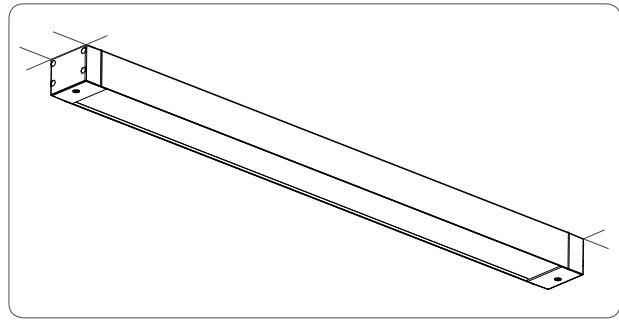
## PROJECT INFORMATION

Project:

Type:

Notes:

REVIT files are available for download at [www.axislighting.com](http://www.axislighting.com)



## PRODUCT ORDERING CODE

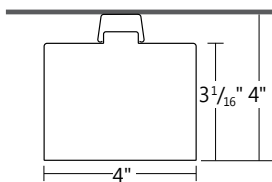
product id	optics lens	length/ft	lamp	lamp config.	finish	voltage	ballast	circuits	suspension/ mounting	power feed	other	controls	custom
<b>WBS</b>			<b>T5</b>						<b>SC</b>				
<b>WBS</b> surface		2 3 4 5 6 8	<b>T5</b>	1 2 lamp lamps	<b>W</b> white <b>AP</b> alu. paint <b>C</b> custom	<b>UNV</b> 120 <b>277</b> <b>347*</b> *Please consult factory	<b>ERS</b> rapid start <b>D</b> dimming <b>T</b> step dimming *See Ballast Guide for further details.	1 one circuit 2 two circuits +E em. circuit	<b>SC</b> surface solid ceiling	<b>EF</b> end feed <b>TF</b> top feed		<b>OS</b> occ. *See Integrated Controls Guide for further details.	<b>C</b> custom (describe below)
<b>F</b> frosted lens <b>C</b> clear lens <b>S</b> satin lens												<b>B#</b> battery pack (specify details) <b>F</b> fuse <b>FW#</b> flex whip (6' std)	

Dimming Ballast, Battery Pack and Integrated Control Details:

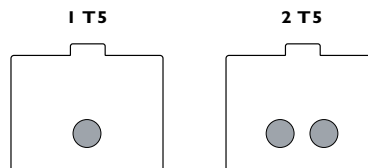
Custom Description:

**i** Specification sheets for other lamping are available for download at [www.axislighting.com](http://www.axislighting.com)

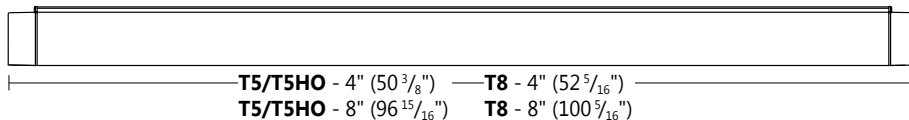
## DIMENSIONS



## LAMPING CONFIGURATIONS



## SIDE VIEW DIMENSIONS



FILE NAME: WBS.T5.SPEC

December 12, 2011

Page: 1 / 4

**ÉCLAIRAGE**  
**axis**  
LIGHTING  
1.800.263.AXIS  
[T] 514.948.6272  
[F] 514.948.6271  
[www.axislighting.com](http://www.axislighting.com)

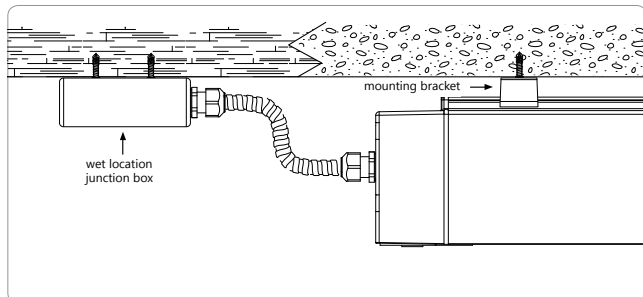


Product design and development is an ongoing process at Axis Lighting. We reserve the right to change specifications. Contact Axis for the latest product information.

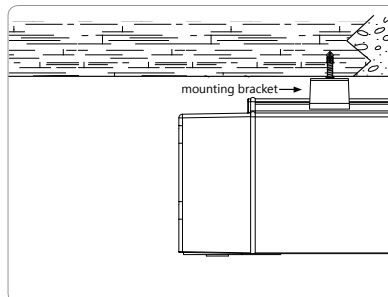
© 2010 Axis Lighting Inc.

## ● MOUNTING OPTIONS

### SC SURFACE SOLID CEILING



Power end feed



Non power feed

## ● OTHER MOUNTING OPTIONS

WET BEAM is available with recessed, pendant, and wall mounted options.

## ● CONSTRUCTION

<b>Housing</b>	Extruded Aluminum (0.062" nominal) 70% Recycled Content ♻️
<b>End Cap</b>	Die Cast Zinc (0.070" nominal)
<b>Interior Brackets</b>	Die Formed Sheet Steel (16 ga)
<b>Gaskets</b>	Moulded Elastomer (0.100" nominal)
<b>Lens Gaskets</b>	Extruded Elastomer (0.045" nominal)
<b>Clear Lens</b>	Extruded Acrylic (0.075" nominal) Clear: 90% transmissive
<b>Frosted Lens</b>	Extruded Acrylic (0.070" nominal) Frosted: 85% transmissive
<b>Satin Lens</b>	Extruded Acrylic (0.070" nominal) Frosted: 68% transmissive
<b>Lamp Options</b>	T5, T5HO, T8

## ● WEIGHT

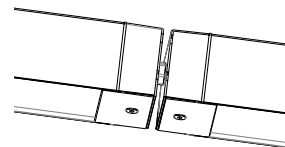
<b>4 ft</b>	12.8 lbs / 5.8 Kg
<b>8 ft</b>	24.5 lbs / 11.1 Kg

## ● GASKETTED FIXTURE

With it's gasketed end cap and lens the Wet Beam is made for wet locations, it is ideal for exterior soffits and canopies of malls, hospitals and other institutions.

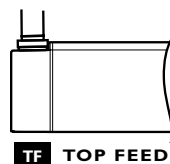
## ● JOINER SYSTEM

Wet Beam modular system consist of smaller modules joined and gasketed together allowing for system runs in lengths of 4' and 8' as well as custom lengths up to 8'.

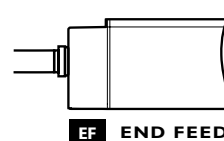


\* For continuous rows allow 2" for connectors between each fixture.

## ● POWER FEED



TF TOP FEED



EF END FEED

## ● FINISH

Aluminium paint, Powder Coated and custom finishes are also available.

## ● ELECTRICAL

<b>Ballast Options</b>	Electronic Rapid Start, Dimming (0-10V, Line, Step, EcoSystem)
<b>Emergency Voltage</b>	Emergency Battery Pack or Circuit 120, 277, 347 2, UNV

## ● APPROVALS

Certified wet locations to UL and CUL standards 

**i** Row configuration, specification sheets and mounting spacing guides are available for download at: [www.axislighting.com](http://www.axislighting.com)

FILE NAME:WBS.T5.SPEC December 12, 2011

Page: 2 / 4

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Product design and development is an ongoing process at Axis Lighting. We reserve the right to change specifications. Contact Axis for the latest product information.

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## LS853LED

Ingrade



The LS853LED is a full featured, shallow depth ingrade luminaire featuring lumen output and efficacy exceeding metal halide. This luminaire also features a universal input driver (120-277 V), and measures only 7.1 inches (180 mm) deep (in direct burial format). The ability to aim the luminaire ensures the most efficient light delivery can be set according to the site conditions.

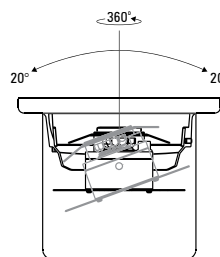
### Specifications

Lamp source	20 W LED
	□ White (4 300 K typical)
	■ Warm white (2 900 K typical)
	■ Blue (470 nm)
	Other colors by request
	■ RGB (consult factory for full details)
UL classification	Suitable for wet locations
Lumen Maintenance (L70)	85,000 hrs @ 25 °C
Control Protocol <i>(optional, consult factory)</i>	0-10 V
	RGB via DMX
IP rating	IP68
Construction	316 marine grade stainless steel
Installation types	Pre-Installation Blockout Concrete pour, drive-over etc.
	Direct Burial Landscapes, planters etc.
Drive-over	With OptiClear™ lens and pre-installation blockout (LS6052-K or LS6052-K-SP)
Static load rating	9 260 lb (4 200 kg) with OptiClear™ lens and pre-installation blockout (LS6052-K or LS6052-K-SP)
Impact rating	IK10 with OptiClear™ lens
Standard inclusions	Teflon coated cover screws
	MicroAntiLeach™ wire entry
	Thermal cutout
Ambient operating temperature	-22 °F to 122 °F (-30 °C to +50 °C)
Surface temperature	≤113 °F (45 °C)
Photometrics	<a href="http://www.lumascape.com">www.lumascape.com</a>

*Any luminaire can become hot - take care with appropriate use and placement*



LS853LED Round Flush Cover



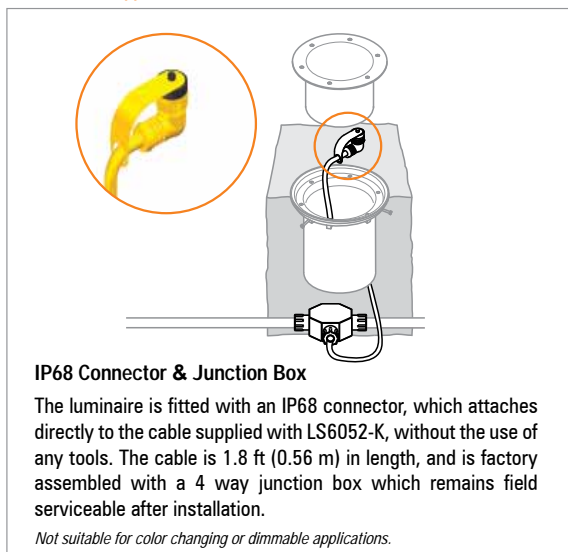
### Why Use LS6052-K Pre-Installation Blockout?

The LS6052-K pre-installation kit (order separately) is a key aspect of Lumascape's approach to engineering high performance ingrade product. The LS6052-K acts as a blockout, and is intended for installation before the luminaire however it has other special functions. To simplify the installation, every LS6052-K is supplied complete with a 4-way, PVC junction box, inside which the installer can make all necessary connections, and allows the completion of all wiring even before the luminaire arrives on site. This method also ensures the luminaire itself is not damaged during concreting or other site works. **Note: The junction box remains serviceable after installation.** To complete the installation, Lumascape provides an IP68 connector, enabling a tool-free final connection from the luminaire to the branch circuit. In addition, this connector is readily detachable, allowing for off-site maintenance.

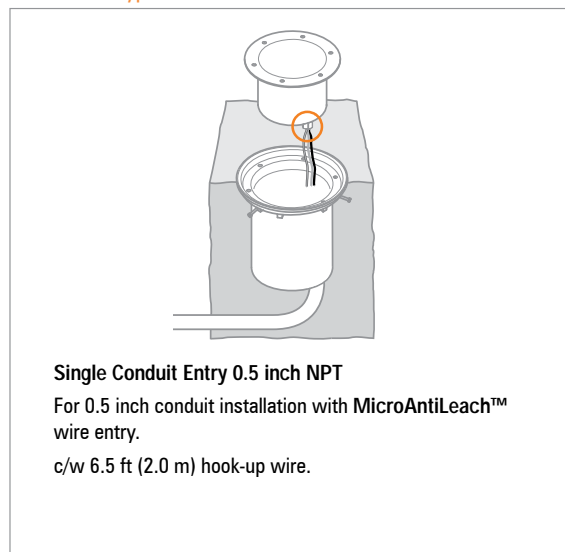
### Why Use LS6052-K-SP Pre-Installation Blockout?

The LS6052-K-SP pre-installation kit (order separately) is ideal for use in applications where maximum flexibility for the type and location of branch circuit connections are required or where exact site conditions may be unknown. The LS6052-K-SP is also for use with all applications requiring a color changing or dimmable lighting scheme. For use with the LS6052-K-SP, Lumascape provides the LS853LED complete with 6.5' of factory-installed hookup wire and a ½" NPT adapter (complete with a Microantileach seal). This provides the installer with greater flexibility to determine the type and location of the branch circuit connection. This option is also 100% hard-wired, and does not feature the IP68 detachable couplings for off-site maintenance. All aspects of the luminaire itself are still field serviceable.

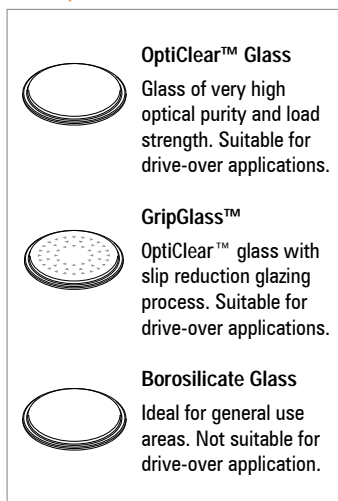
#### Connection Type '85' for LS6052-K Pre-Installation Blockout



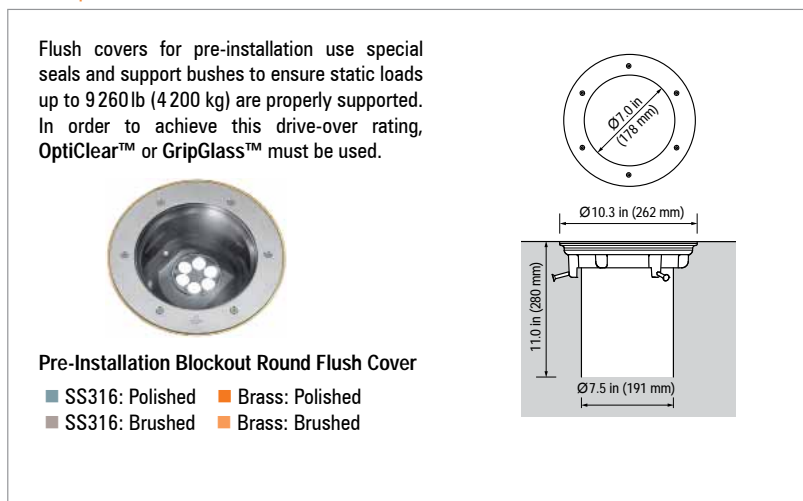
#### Connection Type '82' for LS6052-K-SP Pre-Installation Blockout



#### Lens Options



#### Cover Options for Pre-Installation Blockout



**Product Code**  
LS853LED

**LAMP**

Description	Wattage	Color	Code
LED	20 W	White (4300 K typ.)	20W4
		Warm white (2900 K typ.)	20H6
		Blue (470 nm)	20B4
		RGB	20M4

**LENS**

Description	Code
OptiClear™ Very high optical purity and load strength	A <sup>(1)</sup>
GripGlass™ OptiClear™ with slip reduction glazing process	G <sup>(1)</sup>
Borosilicate Glass Ideal for general use areas	X <sup>(2)</sup>

<sup>(1)</sup> Suitable for drive-over.  
<sup>(2)</sup> Not suitable for drive-over.

**COVER**

Description	Material	Finish	Code
Round Flush Cover	Stainless steel	Polished	M
		Brushed	N
	Brass	Polished	L
		Brushed	K

**CONNECTION TYPE**

Description	Code
IP68 Connector & Junction Box	85 <sup>(1)</sup>
Single Conduit Entry 0.5 inch NPT	82 <sup>(2)</sup>

<sup>(1)</sup> Not suitable for color changing or dimmable applications.  
LS6052-K required - order separately.  
<sup>(2)</sup> LS6052-K-SP required - order separately.

**Optical System Code**

Description	Beam	Code
Adjustable	Narrow	14° N
	Narrow Medium	25° NM
Adjustable	Medium	30° M
	Linear Horizontal	40° x 20° LH
Adjustable	Linear Vertical	20° x 40° LV

NOTE: See beam orientation diagram.

**Body Depth Code**  
29

**Wire Entry Code**  
Q

**Supply Voltage Code**

Voltage	Code
120V 60 Hz	4 <sup>(1)</sup>
277V 60 Hz	9 <sup>(1)</sup>
12 V 60 Hz or 12-24 V DC	13 <sup>(2)</sup>

<sup>(1)</sup> Not available for RGB.  
<sup>(2)</sup> For appropriate transformer sizing refer to page 54 - 55 of the Lumascape LED catalog.

**LS853LED Accessories**

**Stacking and order of accessories**

LED

Linear spreader lens (LS685) OR Prismatic lens (LS691)

Slatted louver (LS6013) OR Wall wash lens (LS688) OR Cross hatch louver (LS6012)

Other accessory stacking options may be available - consult factory



**DESCRIPTION**

Cambria 203 is an ultra-compact low voltage LED and halogen MR16 fixture. It is available with a fully adjustable side swivel stem (203, 203-FL), an adjustable center rear swivel (203-CRS) or a stationary rear flush mount (203-FM). Various lenses, louvers and color or dichroic filters can be combined - up to three at once - to create multiple lighting effects. Lumiere's exclusive Siphon Protection System (S.P.S.) prevents water from siphoning into the fixture through its own lead wires.

Catalog #		Type
Project		
Comments		Date
Prepared by		

**SPECIFICATION FEATURES****A ... Material**

Housing, hood and mounting stem are precision-machined from corrosion-resistant billet stock 6061-T6 aluminum, C360 brass, C932 bronze, C110 copper or 303/304 stainless steel.

**B ... Finish**

Fixtures constructed from 6061-T6 aluminum are double protected by a chemical film undercoating and polyester powdercoat paint finish, surpassing the rigorous demands of the outdoor environment. A variety of standard colors are available.

**C ... Brass, Bronze, Copper or Stainless Steel**

Fixtures constructed from brass, bronze, copper or stainless steel are left unpainted to reveal the natural beauty of the material. Brass, bronze and copper will patina naturally over time.

**D ... Hood**

Hood is removable for easy relamping and accepts up to three internal accessories at once (lenses, louvers, filters) to achieve multiple lighting effects. Model 203, 203-CRS & 203-FM: Weep holes prevent water and mineral stains from collecting on the lens, even in the straight-up position. Model 203-FL: The flush lens design reduces debris collection and minimizes debris collection and prevents water and mineral stains from collecting on the lens.

**E ... Gasket**

Housing and hood are sealed with a high temperature silicone o-ring gasket to prevent water intrusion.

**F ... Lens**

Tempered glass lens, factory sealed with high temperature adhesive to prevent water intrusion and breakage due to thermal shock.

**G ... Mounting Stem**

Model 203 and 203-FL include a fully adjustable side-mounted swivel stem, providing 340° tilt and 360° rotation for easy aiming. Center rear swivel (203-CRS) or stationary rear flush mount (203-FM) models are also available. All models include 1/2" NPS

threaded male fitting. Stainless steel aim-locking mechanisms are standard (not available on 203-FM). Lumiere's exclusive Siphon Protection System (S.P.S.) prevents water from siphoning into the fixture through its own lead wires.

**H ... Hardware**

Stainless steel hardware is standard to provide maximum corrosion-resistance.

**I ... Socket**

Ceramic socket with 250°C Teflon coated lead wires and GU5.3 bi-pin base.

**J ... Electrical**

Remote 12V transformer required (not included). Transformers used in conjunction with LED's must be magnetic only, not electronic. Available from Lumiere as an accessory - see the Accessories & Technical Data section of the catalog for details. NOTE: initial power draw on LED equipped fixtures can be up to 20 watts in cold weather. When sizing transformer use 20 watts per LED fixture. Nominal power draw after start up is 12 watts. Also, LEDs are more voltage sensitive than standard halogen MR16 lamps. The LED module is designed to operate between 10 and 13 volts. Any less or more voltage can cause premature failures. Lumiere recommends the use of a surge protector with all remote transformers feeding LEDs. Lumiere's 10kV fuse and MOV module can be ordered separately under catalog # LEDSURGE.

**K ... Lamp**

Halogen lamp not included. Available from Lumiere as an accessory - see reverse side for details and catalog logic. Due to the onboard thermal feedback control circuitry, LED modules are non-dimmable. LED modules are included and are available in three color temperatures (warm, neutral and cool) and three distributions (spot, narrow and flood). Both color temperature and distribution must be specified when ordering - see reverse side for details and catalog logic.

**L ... Labels & Approvals**

UL and cUL listed, standard wet label. IP65 rated. Manufactured to ISO 9001-2000 Quality Systems Standard. IBEW union made. Approved by New York City Department of Buildings, Bureau of Electrical Control for use in NYC, NY.

**M ... Warranty**

Lumiere warrants its fixtures against defects in materials & workmanship for three (3) years. Auxiliary equipment such as transformers, ballasts and lamps carry the original manufacturer's warranty.



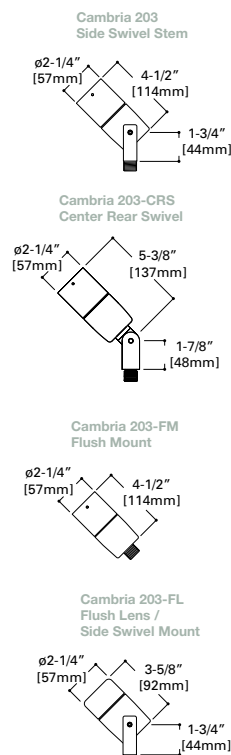
## CAMBRIA 203

12W LED

12V 50W MR16

Accent / Flood

IP65



## LAMP INFORMATION

Lamp	ANSI Code	Watts	Beam Spread	CBCP	°K	Life (hrs.)	Base	Volts
12WLEDS		12	7°	11399	3000	50000	GU5.3 bi-pin	12
12NLEDS		12	7°	13725	4300	50000	GU5.3 bi-pin	12
12CLEDS		12	7°	14657	6300	50000	GU5.3 bi-pin	12
12WLEDN		12	19°	1160	3000	50000	GU5.3 bi-pin	12
12NLEDN		12	19°	1495	4300	50000	GU5.3 bi-pin	12
12CLEDN		12	19°	1794	6300	50000	GU5.3 bi-pin	12
12WLEDW		12	25°	1066	3000	50000	GU5.3 bi-pin	12
12NLEDW		12	25°	1414	4300	50000	GU5.3 bi-pin	12
12CLEDW		12	25°	1461	6300	50000	GU5.3 bi-pin	12
50MR16 / NSP	EXT	50	12°	11000	3050	4000	GU5.3	12
50MR16 / NFL	EXZ	50	25°	3200	3050	4000	GU5.3	12
50MR16 / FL	EXN	50	40°	2000	3050	4000	GU5.3	12
50MR16 / WFL	FNV	50	60°	1200	3050	4000	GU5.3	12

## Notes &amp; Formulas:

Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.

Footcandle values are initial.

For halogen sources, apply appropriate light loss factors where necessary.

For LED sources, light loss factor has already been applied.

For halogen sources, bare lamp data is shown.

Consult lamp manufacturers to obtain detailed specifications for their lamps.

## ORDERING INFORMATION

Series	Source	Voltage	Finish	Accessories
<b>203</b> = LED or MR16 Cambria Accent Fixture Side Swivel Stem <b>203-CRS</b> = LED or MR16 Cambria Accent Fixture Center Rear Swivel <b>203-FM</b> = LED or MR16 Cambria Accent Fixture Flush Mount <b>203-FL</b> = LED or MR16 Cambria Accent Fixture Flush Lens/ Side Swivel Stem	<b>HALOGEN</b> <b>50MR16</b> = 50W Max Halogen MR16, GU5.5 Base  <b>LED</b> <b>12WLEDS</b> = 12W Warm LED Spot Optic, GU5.3 Base <b>12NLEDS</b> = 12W Neutral LED Spot Optic, GU5.3 Base <b>12CLEDS</b> = 12W Cool LED Spot Optic, GU5.3 Base <b>12WLEDN</b> = 12W Warm LED Narrow Optic, GU5.3 Base <b>12CLEDN</b> = 12W Cool LED Narrow Optic, GU5.3 Base <b>12WLEDW</b> = 12W Warm LED Wide Optic, GU5.3 Base <b>12NLEDW</b> = 12W Neutral LED Wide Optic, GU5.3 Base <b>12CLEDSW</b> = 12W Cool LED Wide Optic, GU5.3 Base <b>12NLEDN</b> = 12W Neutral LED Narrow Optic, GU5.3 Base	<b>12</b> = 12V	<b>Painted</b> <b>BK</b> = Black <b>BZ</b> = Bronze <b>CS</b> = City Silver <b>VE</b> = Verde <b>WT</b> = White  <b>Premium Material</b> <b>NBR</b> = Natural Brass <b>NBZ</b> = Natural Bronze <b>NCP</b> = Natural Copper <b>NSS</b> = Natural Stainless Steel	<b>Filters</b> <b>F71</b> = Peach Dichroic Filter, 2.00" Dia <b>F72</b> = Amber Dichroic Filter, 2.00" Dia <b>F73</b> = Green Dichroic Filter, 2.00" Dia <b>F74</b> = Medium Blue Dichroic Filter, 2.00" Dia <b>F75</b> = Yellow Dichroic Filter, 2.00" Dia <b>F76</b> = Red Dichroic Filter, 2.00" Dia <b>F77</b> = Dark Blue Dichroic Filter, 2.00" Dia <b>F78</b> = Light Blue Dichroic Filter, 2.00" Dia <b>F79</b> = Neutral Density Dichroic Filter, 2.00" Dia <b>F80</b> = Magenta Dichroic Filter, 2.00" Dia <b>F22</b> = Red Color Filter, 2.00" Dia <b>F33</b> = Blue Color Filter, 2.00" Dia <b>F44</b> = Green Color Filter, 2.00" Dia <b>F55</b> = Yellow Color Filter, 2.00" Dia <b>F66</b> = Mercury Vapor Color Filter, 2.00" Dia  <b>Optical Lenses</b> <b>LSL</b> = Linear Spread Lens (elongate standard beam spread), 2.00" Diameter <b>DIF</b> = Diffused Lens (provide even illumination), 2.00" Diameter <b>OSL</b> = Overall Spread Lens (increase beam spread), 2.00" Diameter  <b>Optical Louver</b> <b>LVR</b> = 45° Hex Cell Louver (reduce glare), 2.00" Diameter

## Sample Number: 203-12WLEDN-12-BK

## Notes:

- lamp not included
- 12V remote transformer required - not included
- See ACCESSORIES & TECHNICAL DATA section of the Lumiere catalog for Low Voltage Cable & Transformers
- Consult your Cooper Lighting representative for additional options and finishes

## LAMPS

## MR16

**EZX** = 20W MR16 GU5.3 Bi-Pin Very Narrow Spot  
**BAB** = 20W MR16 GU5.3 Bi-Pin Flood  
**FRA** = 35W MR16 GU5.3 Bi-Pin Spot  
**EXT** = 50W MR16 GU5.3 Bi-Pin Narrow Spot  
**EXN** = 50W MR16 GU5.3 Bi-Pin Flood

**ESX** = 20W MR16 GU5.3 Bi-Pin Narrow Spot  
**FRB** = 35W MR16 GU5.3 Bi-Pin Narrow Spot  
**FMW** = 35W MR16 GU5.3 Bi-Pin Flood  
**EXZ** = 50W MR16 GU5.3 Bi-Pin Narrow Flood  
**FNV** = 50W MR16 GU5.3 Bi-Pin Very Wide Flood

  
**COOPER** Lighting  
 www.cooperlighting.com

Specifications and Dimensions subject to change without notice.  
 Lumiere • Customer First Center • 1121 Highway 74 South • Peachtree City, GA 30269 • TEL 770.486.4800 • FAX 770.486.4801

09/23/2010

# SPECIFICATION SHEET

**lumenbeam™**

MEDIUM  
WHITE & STATIC COLORS

LIGHTING DESIGN ALLIANCE

Client: \_\_\_\_\_  
Project name: \_\_\_\_\_  
Order #: \_\_\_\_\_  
Type: \_\_\_\_\_ Qty: \_\_\_\_\_

## FEATURES AND BENEFITS

### Physical :

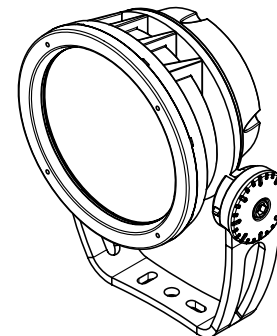
- Low copper content high pressure die-cast aluminum housing
- Heavy aluminum formed yoke (standard yoke included)
- Stainless steel hardware
- Silicone sealing devices
- Clear tempered glass
- Dual chamber design for heat management and ease of maintenance
- Electro-statically applied polyester powder coat finish
- 3.05 kg / 6.7 lbs
- IP66
- EPA: Front = 0.46 sq. ft. Side = 0.37 sq. ft.

### Performance :

- Minimum 1fc (10.7 lux) @ 238 feet (72.5m) distance (4000K, 6° optic)
- 1,400 delivered lumens and 56,521 candelas at nadir (4000K, 6° optic)
- 6°, 10°, 20° or 40°, Elliptical distribution on 10° and 40° optics
- Lumen maintenance L70 @ 25°C - 120,000 hrs
- Lumen measurements comply with LM - 79 - 08 standard
- Operating temperatures : -25°C to 50°C

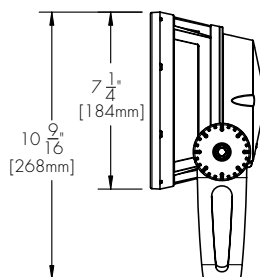
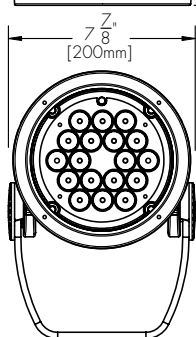
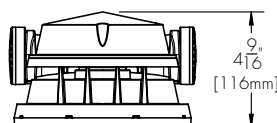
### Electrical :

- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable, 3ft cord (#16-5)
- 27 watts
- 0-10 volt, DMX or DALI dimming options

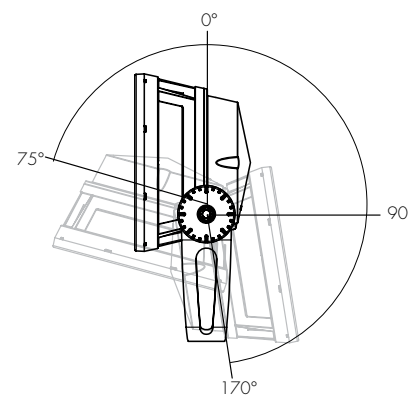


### Wiring detail

WIRE COLOR / USE	
GREEN	GROUND
WHITE	NEUTRAL
BLACK	LIVE 120-277V
RED	0-10V / DATA +
ORANGE	0-10V / DATA -



Standard Yoke (as shown, included)



Standard Yoke Mounting  
Adjustable pivot limits

5 year warranty

1/11

Lumenpulse, 1751 Richardson, Suite 1505, Montreal (Quebec) Canada H3K 1G6 1.877.937.3003 P. 514.937.3003 F. 514.937.6289  
info@lumenpulse.com www.lumenpulse.com  
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JULY 16, 2012

LIGHTING CATALOG PAGE

THE LIGHTING DESIGN ALLIANCE, INC.

LOS ANGELES  
2830 TEMPLE AVENUE  
LONG BEACH, CA 90806-2213

T: 562.989.3843  
F: 562.989.3847  
www.LightingDesignAlliance.com

TYPE  
**JD2**  
1 of 3

# SPECIFICATION SHEET

**lumenbeam™**

MEDIUM  
WHITE & STATIC COLORS

Client: \_\_\_\_\_  
Project name: \_\_\_\_\_  
Order #: \_\_\_\_\_  
Type: \_\_\_\_\_ Qty: \_\_\_\_\_

## FEATURES AND BENEFITS

### Physical :

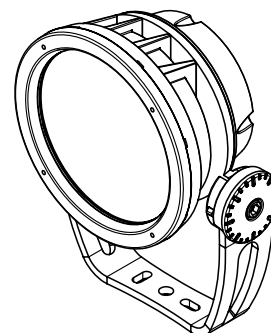
- Low copper content high pressure die-cast aluminum housing
- Heavy aluminum formed yoke (standard yoke included)
- Stainless steel hardware
- Silicone sealing devices
- Clear tempered glass
- Dual chamber design for heat management and ease of maintenance
- Electro-statically applied polyester powder coat finish
- 3.05 kg / 6.7 lbs
- IP66
- EPA: Front = 0.46 sq. ft. Side = 0.37 sq. ft.

### Performance :

- Minimum 1fc (10.7 lux) @ 238 feet (72.5m) distance (4000K, 6° optic)
- 1,400 delivered lumens and 56,521 candelas at nadir (4000K, 6° optic)
- 6°, 10°, 20° or 40°, Elliptical distribution on 10° and 40° optics
- Lumen maintenance L70 @ 25°C - 120,000 hrs
- Lumen measurements comply with LM - 79 - 08 standard
- Operating temperatures : -25°C to 50°C

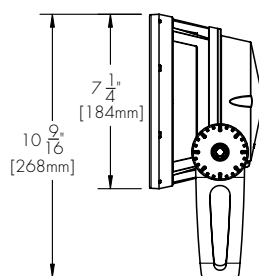
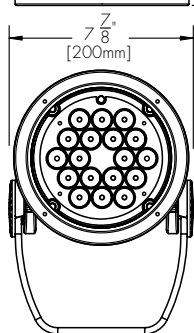
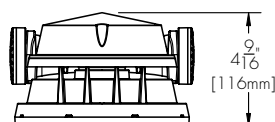
### Electrical :

- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable, 3ft cord (#16-5)
- 27 watts
- 0-10 volt, DMX or DALI dimming options

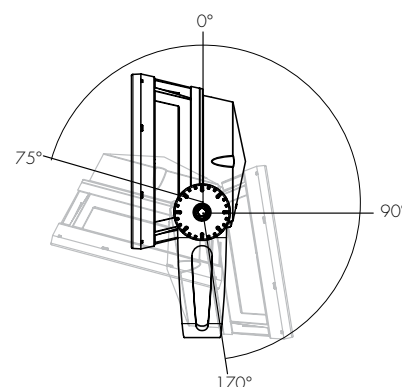


### Wiring detail

WIRE COLOR / USE	
GREEN	GROUND
WHITE	NEUTRAL
BLACK	LIVE 120-277V
RED	0-10V / DATA +
ORANGE	0-10V / DATA -



Standard Yoke (as shown, included)



Standard Yoke Mounting  
Adjustable pivot limits

5 year warranty

1/11

Lumenpulse, 1751 Richardson, Suite 1505, Montreal (Quebec) Canada H3K 1G6 1.877.937.3003 P. 514.937.3003 F. 514.937.6289  
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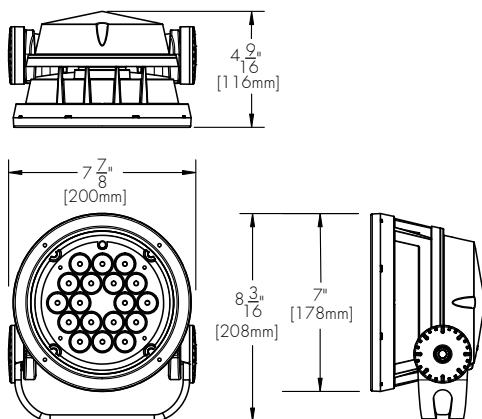
TYPE  
**JD2**  
2 of 3

# SPECIFICATION SHEET

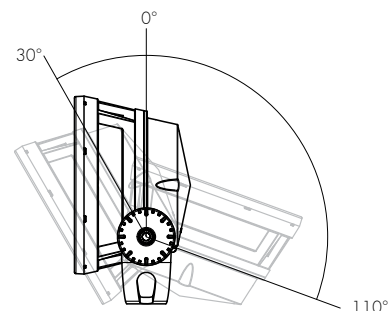
**lumenbeam™**

MEDIUM  
WHITE & STATIC COLORS

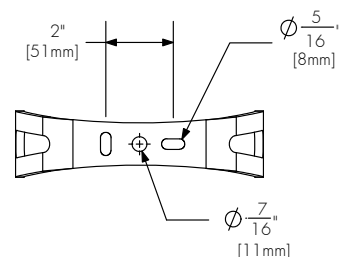
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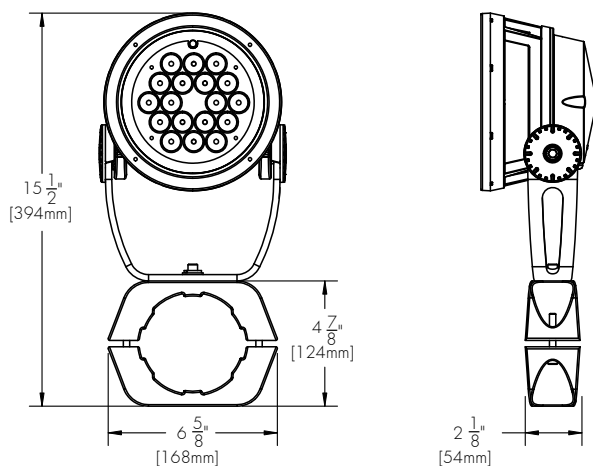
**SY**  
Short Yoke Mounting



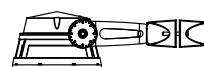
Short Yoke mounting  
adjustable pivot limits



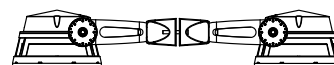
Standard and Short Yoke mounting  
holes pattern



**PM**  
Round Pole Mounting Accessory  
\*Consult factory for square pole section



**PM4-1, PM4.5-1, PM5-1**  
Round Pole Mounting accessory  
single fixture



**PM4-2, PM4.5-2, PM5-2**  
Round Pole Mounting accessory  
twin fixtures

When **PM4-2, PM4.5-2 or PM5-2** are specified,  
one bracket assembly is supplied per 2 fixtures unless  
otherwise specified.

2/11

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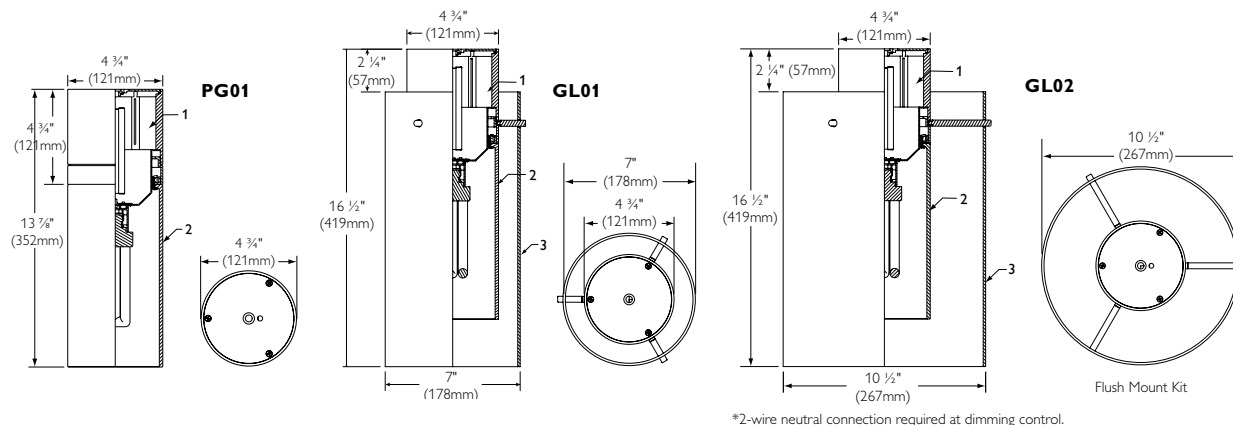
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www.LightingDesignAlliance.com

TYPE  
**JD2**  
3 of 3

# PM Series

## Decorative, Vetro Pendant CFL & INC

Page 1 of 7



\*2-wire neutral connection required at dimming control.

**Ordering Information:** Complete fixture consists of powerhead + inner diffuser + outer glass/acrylic + suspension kit.  
Each sold separately (ie **PM32SA + PG01 + GL01 + SK01**).

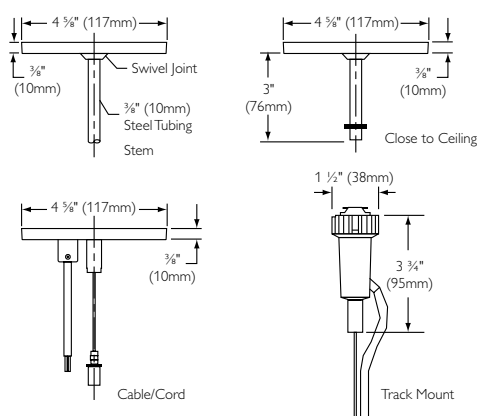
Powerhead	Inner Diffuser	Outer Glass/Acrylic	Suspension Kit	Lamp	Volts
<b>PM32SA</b>	<b>PG01 or PA01</b>	<b>GL02, GL02A, GL01, or GL01A</b>	See suspensions below	CFL, 26/32	<b>120/277V</b>
<b>PM32MX1SA</b>				Mark X Dimming 26/32W	<b>120V</b>
<b>PM32MX2SA</b>				Mark X Dimming 26/32W	<b>227V</b>
<b>PM150SA*</b>	<b>PG01 only</b>	<b>GL01 or GL02 only</b>		T-4 Mini-Can 150W	<b>120V</b>

Must order Powerhead and Glass separately. Suspension Kit must be ordered separately. Spec ID is for reference only. \*DO NOT USE with acrylic accessories.

### Suspension Kits:

Catalog No.	Finish	Description
<b>SK01</b>	Satin aluminum	Clear metallic straight Cord/Cable, 120" Length, (10') with canopy
<b>SK02</b>	Satin aluminum	Clear metallic straight Cord/Cable, 300" Length, (25') with canopy
<b>ST01</b>	Satin aluminum	36" Length 3/8" Stem with canopy
<b>ST02</b>	Satin aluminum	60" Length 3/8" Stem with canopy
<b>CTC</b>	Satin aluminum	Close To Ceiling Kit with canopy
<b>TM01</b>	Satin aluminum	Silver Track Mounting Kit with clear metallic straight Cord/Cable, 120" Length, (10') (120V only)
<b>SMK</b>	Satin aluminum	Flush Mounting Kit

### Mounting Options



Job Information	Type:
Job Name:	
Cat. No.:	
Notes:	

**PHILIPS**  
**LIGHTOLIER**

# Narrow T5 Strip **SV T5 Strip**

Page 1 of 2

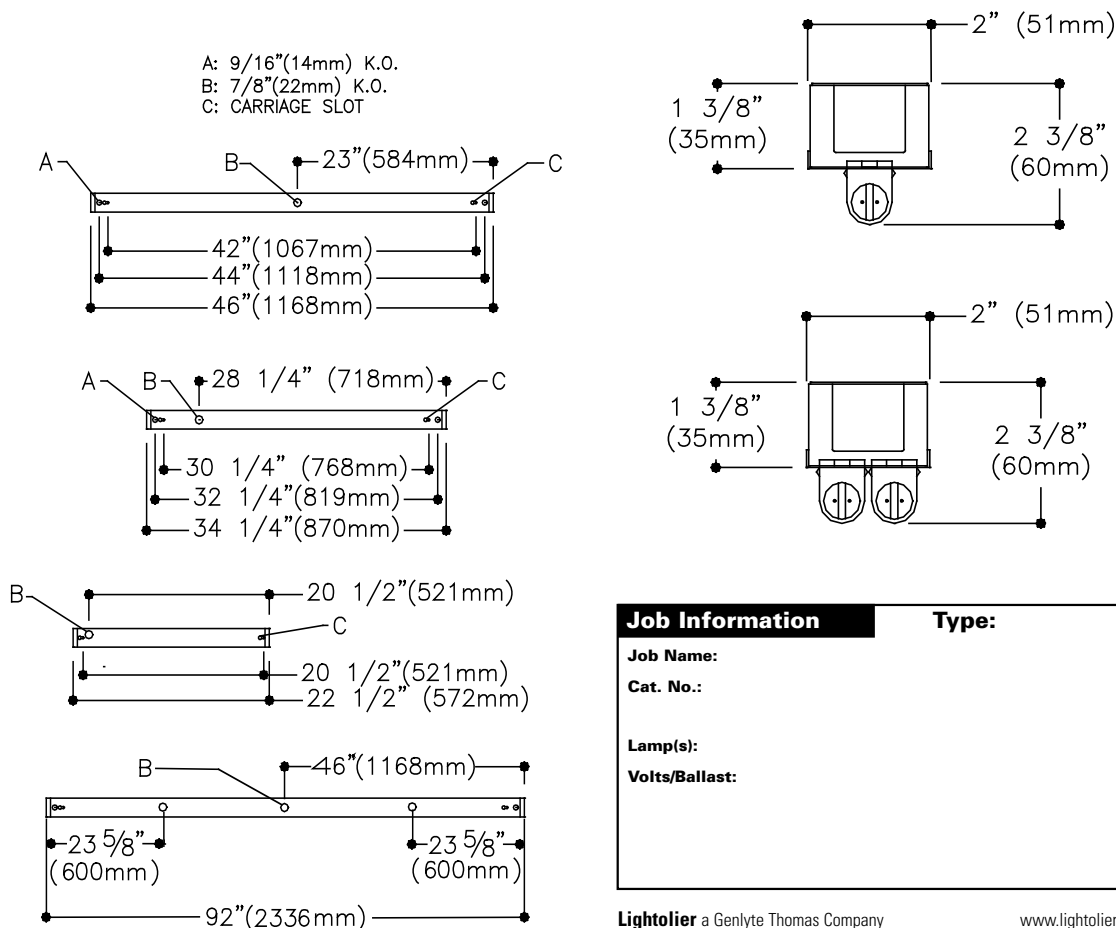
2" Wide 1 3/8" Deep, 22", 34", 46" or 92" Lengths, 1 or 2 Lamp, T5

## Features

- Only 2" wide.
- Utilizes compact, high efficiency, T5 or T5HO lamps.
- Fully enclosed wiring.
- Optional white or specular, symmetric and asymmetric reflector.
- Convenience outlet and switch K.O.s provided
- Push through lamp holders with rotor for secure lamp retention.
- Optional hangers and wires guards.



## Dimensions



## Job Information

## Type:

Job Name:

Cat. No.:

Lamp(s):

Volts/Ballast:

**Lightolier** a Genlyte Thomas Company [www.lightolier.com](http://www.lightolier.com)  
 Technical Information: (978) 657-7600 • Fax (978) 658-0595  
 631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710  
 We reserve the right to change details of design, materials and finish.  
 Copyright 2002 Lightolier **Section 3A/Folio H120-17**

**LIGHTOLIER®**

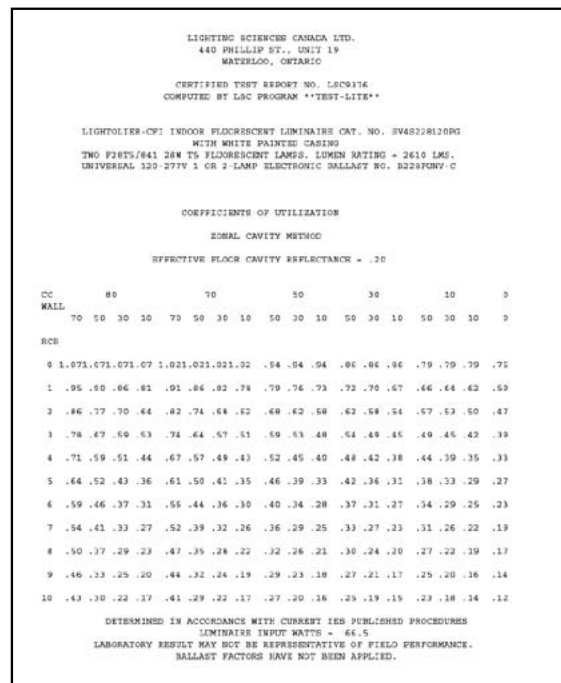
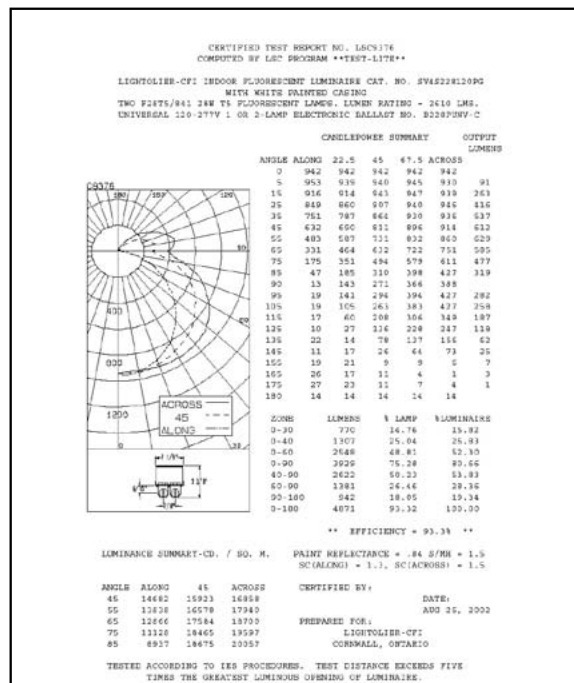
5/03



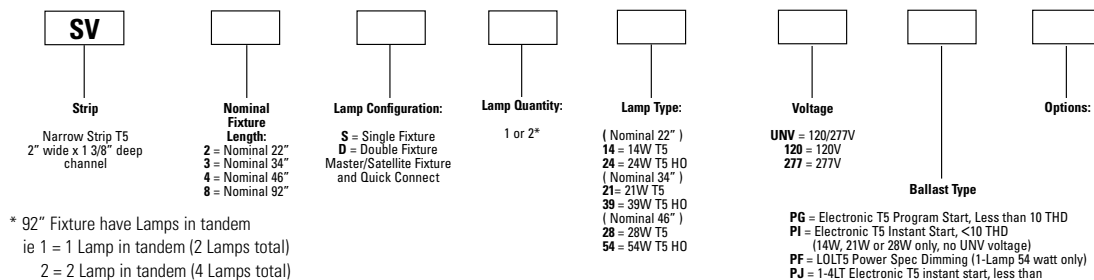


2" Wide 1 3/8" Deep, 22", 34", 46" or 92" Lengths, 1 or 2 Lamp, T5

**Model No. SV4S228120PG**



Explanation of Catalog Number. Example: SV4S228120PG



**Stem and Canopy Sets:** Suspend luminaire 12", 18", 24", 36", or 48" from surface. (Two per luminaire is recommended. For 34" and 46" **SV Strip** only.) Catalog number: **SV5F12** (12"); **SV5F18** (18"); **SV5F24** (24"); **SV5F36** (36"); **SV5F48** (48").

**Chain Hanging Kit:** Includes two 5' heavy duty link chains with sturdy "V" hook for fixture suspension. (34" and 46" Strip only.) Catalog number: **EE9HC**  
**Wire Guard:** White wire guard. Catalog number: For SV Strip T5 34"; **SV5GXW3**.  
 For SV Strip T5 46"; **SV5GXW4**.

**Reflector:** Consult specification sheet (folio H120-22 & H120-20).

**Radio Interference Filter:** 120, 277 or UNV volt, 50 or 60 Hz. Suffix: **R**

**Ballast Options:** For other ballast options, consult factory

**Materials:** Chassis parts are die-formed heavy gauge cold rolled steel, 1-3/8" deep x 2" channel width.

**Finish: Chassis exterior** - phosphate undercoating, baked white acrylic matte high reflectance paint finish.

**Electrical:** HPF, thermally protected class "P" ballast. If K.O.s are within 3" of ballast use wire suitable for at least 90°.

**Labels:** Listed by



## Type:

**Lightolier** a Genlyte Thomas Company [www.lightolier.com](http://www.lightolier.com)

Technical Information: (978) 657-7600 • Fax (978) 658-0595

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Section 3A/Folio H120-17

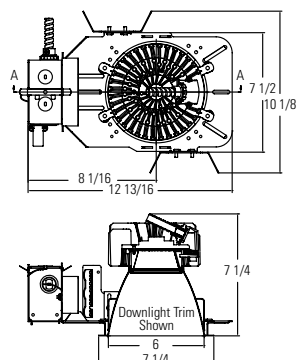


# Calculite LED Frame-In Kit **C6L15/CUL15**

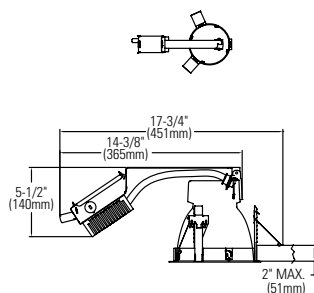
Page 1 of 1

1500 Lumen, 6" Aperture Remote Phosphor LED

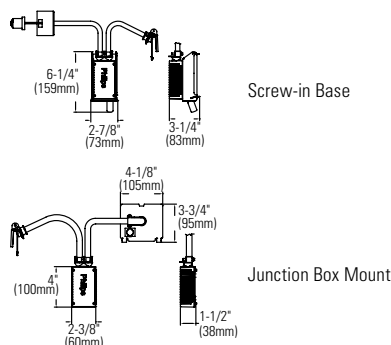
## New Construction Frames



## Remodeler Frames



## Retrofit Frames



## Ordering Guide: Frame-in Kits

Frame-in Kit Series	Installation Options	Input Voltage	Options
<b>C6L15</b> (1500 Lumen)	<b>N</b> (New construction) <b>R</b> (Remodeler)	<b>1</b> (120V) <b>2</b> (277V)	<b>Blank</b> (0-10 volt dimming) <b>EM</b> (Emergency)
<b>CUL15</b> (1500 Lumen)	<b>J</b> (J-box mount retrofit) <b>S</b> (Screw-in base retrofit (120V only))	<b>1</b> (120V) <b>2</b> (277V)	<b>Blank</b> (0-10 volt dimming)

Example: C6L15N1EM

## Features

**Ceiling Cutout:** 6 9/16" (167mm)

**Depth (including Light Engine):** See Light Engine specification sheet for details.

**Power Connection:** Attaches to light engine via push-in connector (on frame). Removable cover provides access.

**Junction Box:** UL listed for 8 No. 12 AWG, 90°C through branch circuit connectors. Allows inspection from below.

**Thermal Protector:** Meets NEC & UL requirements. Do not install insulation above nor within 3" of any part of luminaire.

## New Construction Frame:

**Mounting Frame:** Galvanized stamped steel for dry or plaster ceilings.

**Vertical Adjustment:** Light engine adjusts in frame below ceilings up to 1 1/8".

**Mounting Brackets:** Galvanized Steel. Adjustable through aperture. Use 3/4" or 1 1/2" lathing channel, 1/2" EMT or optional mounting bars.

## Remodeler Frame:

**Power Pack:** Swivel junction box for tight plenum spaces. Snap-off covers permits wiring from top.

**Spring Holder:** Galvanized steel. Accepts up to 2 1/2" (64mm) ceiling thickness.

## Retrofit Frame:

**Capability:** Converts 6" (153mm) or 7" (178mm) Lightolier incandescent frame-in kit without additional wiring using existing Calculite E26 base.

**Socket Cup Support:** Spun steel. Holds Calculite incandescent socket cup.

**Socket Extender:** Phenolic E26 base. Connect to existing lampholder.

## Electrical

Electronic Power Supply: 120 or 277V, 50/60Hz, encased, overload and short circuit protected, thermal regulation to protect against overheating, sound rating "A", -20°C minimum starting temperature, 70°C maximum operating temperature, dimmable with 0-10V dimmer. Dimming compatibility: See LED-DIM specification sheet.

## Electrical (continued)

Input Voltage	Input Frequency	Input Current	LED Drive Current	Input Power	LED Power	THD	Power Factor
120V	50/60Hz	0.25	350mA	27W	23.1W	<1%	>0.9
277V	50/60Hz	0.11	350mA	27W	23.1W	<1%	>0.9

**Rated Life:** 100,000 hours

## Options and Accessories

**Dimming Capability:** 0-10V. See LED-DIM specification sheet

**Emergency Capability (Integral):** Add "EM" suffix. See LED-EM spec sheet.

**Emergency Capability (Inverter):** See LED-LMI specification sheet

**Sloped Ceilings:** See specification sheet SCA.

**Mounting Bars:** 1950-18" Set of (2)

1951-27" Set of (2)

**T-Bar Anchor Clips:** 1956-Set of (4), for use with above

## Labels

UL, cUL, I.B.E.W.

5 Year Warranty

Job Information	Type:
<b>Job Name:</b>	
<b>Cat. No.:</b>	
<b>Lamp(s):</b>	
<b>Notes:</b>	

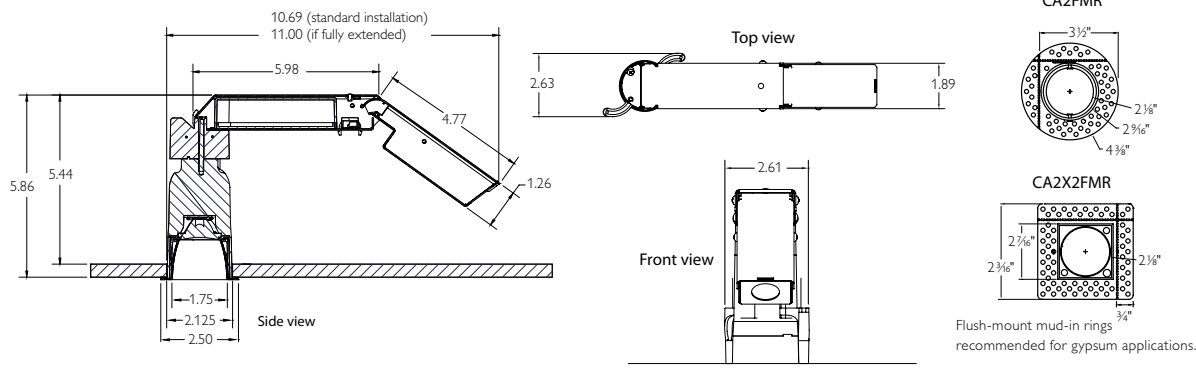
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# C2L04

## Calculite 1.75" Aperture, 400 Lumen LED

Page 1 of 7



### Ordering Guide: Frame-in Kits

Frame-in Kit Series	Lumen Package (nominal)	Style	Color Temperature	Beam Spread	Installation Style <sup>2</sup>	Input Voltage
C2L	04 (400 Lumens)	DL (Downlight flanged) DLFT (Downlight flush-mount) <sup>1</sup>	30K (3000K)	12 (12 degrees) 17 (17 degrees) 25 (25 degrees) 38 (38 degrees)	R (install-from-below)	1 (120V)
		<sup>1</sup> requires "FT" series reflectors				

### Ordering Guide: Reflectors

Reflector Series	Style	Finish	Flange
C2L (Round)	DL (Downlight-50° cutoff) DLLS (Downlight with linear spread lens-75° cutoff) LW (Lensed Wall Washer) <sup>3,4</sup>	BK (Black) CCD (Comfort Clear Diffuse) CCZ (Champagne Bronze) WH (Painted White)	P (aperture-matching) FT (Flush mount)*
C2X2L (Square)	DL (Downlight-50° cutoff) LW (Lensed Wall Washer) <sup>3</sup>	BK (Black) WH (Painted White)	P (Aperture-matching) FT (Flush-mount)*
		*requires "FT" series frame-in kit	
		<sup>3</sup> 17° beam spread recommended <sup>4</sup> 18" max installation from vertical surface recommended	

Job Information	Type:
Job Name:	
Cat. No.:	
Notes:	

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# C2L04

## Calculite 1.75" Aperture, 400 Lumen LED

Page 2 of 7

### Features

**Aperture:** 1.75" (44 mm) I.D., 2.50" (63mm) O.D.

**Input Wattage:** 11W max. (C2L04)

**Fixture Output:** Aluminum. Provides 50° cutoff to source & source image. Self-flanged.

### Beam Spread options:

Beam Spread	Spacing Criterion	Delivered Lumens	Efficacy	CBCP
12°	0.2	328 lm	29.8 lm/w	5099
17°	0.3	412 lm	37.3 lm/w	3282
25°	0.4	382 lm	36.0 lm/w	1995
38°	0.6	377 lm	34.9 lm/w	936

**Reflector Cone:** Aluminum. Provides 50° cutoff to source & source image. Twist & lock installation within frame-in kit ensures snug fit to ceiling.

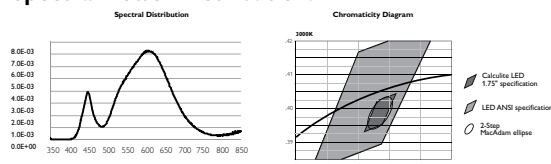
### Technology

**Array:** 4-chip LED array featuring 2-step SDCM binning control

**Photometric Performance:** Tested in accordance to IESNA LM-79-2008

**Color Consistency:** 2 SDCM (max.)

### Spectral Power Distribution:



**Color Rendering Index:** 80 min, 82 typical

Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9
81.0	80.2	87.1	91.0	78.9	78.3	81.0	85.6	66.2	21.3
R10	R11	R12	R13	R14					
67.7	74.9	62.1	81.4	94.2					

**Dimming Capability:** ELV dims to nominal 10% lumen output. See LED-DIM specification sheet for dimming system compatibility.

**Emergency Capability (Inverter):** Yes.

See LED-LMI specification sheet

### Rated Life

**LED Array:** 50,000 hours at 70% lumen maintenance (L70, B50). Based on IESNA LM-80-2008.

**Driver:** 50,000 hours

### Features (continued)

**Reflector Flange:** Thickness: 0.09" (2.4 mm). Width (flanged) 0.37" (9.5 mm). Width "flush-mount) 0.19" (4.8 mm)

**Required Depth:** 5.91" (150 mm). 5.5" plenum depth required for Non-IC installation. see above for fixture dimensions

**Ceiling Cutout:** 2.125" (54mm)

**Installation:** Hinged design allows fixture to be installed from below ceiling. Two screws actuate pivoting installation arms. Vertical installation only (as shown in above drawings).

**Thick Ceiling Capability:** 3/8" - 2".

**Optical Accessories:** One (1) accessory as defined in "Accessories-Optical" below. Accessories install securely to top of reflector housing. Proper positioning ensured via offset die cut.

**Field Accessibility:** LED array, beam spreads (optics) and driver are field interchangeable/replaceable

### Electrical

**Power connection:** Integral connection between driver and LED array

**Junction Box:** UL listed for 6 No 12 AWG, 90°C through branch circuit connectors. Allows inspection from below. Compatible with 2-1 conduit connector for daisy chaining.

**Minimum Starting Temperature:** -20°C

**Maximum Operating Temperature:** 60°C

**Input Voltage:** 120V

**Input Frequency:** 60Hz

**Input Current:** .09A

**LED Drive Current:** 670mA

**Input Power:** 11W

**LED Power:** 9.1W

**THD:** <20%

**Power Factor:** >0.9

**FCC Rating:** Class A, Class B pending

### Labels

UL, cUL, I.B.E.W

17°, 25° & 38° beams suitable for wet location

12° beam suitable for damp location 5 year warranty

**Job Information** **Type:**

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# C2L04

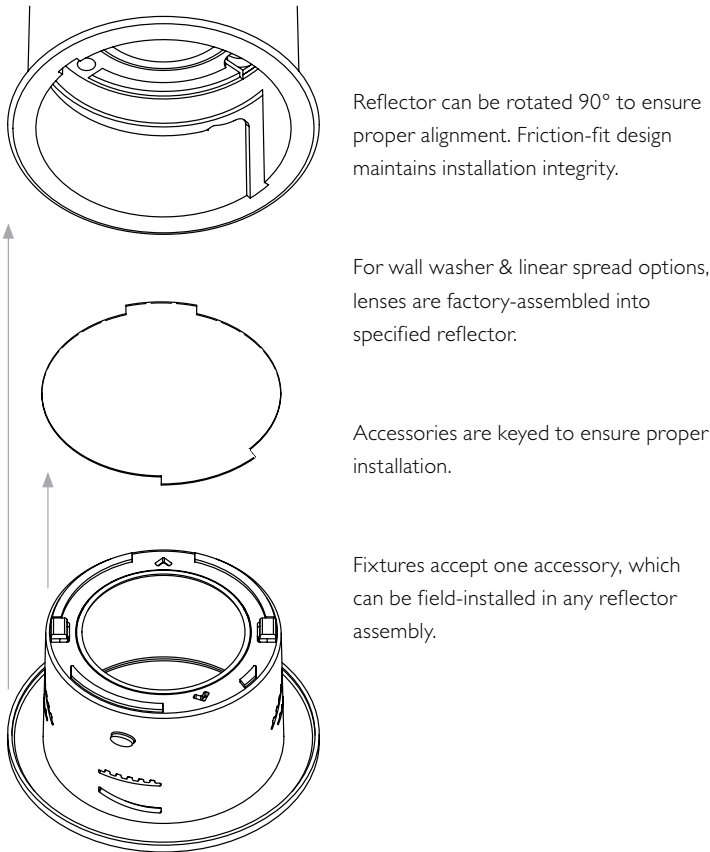
## Calculite 1.75" Aperture, 400 Lumen LED

Page 3 of 7

### Ordering Guide: Accessories

Accessories-Optical	Lumen Package (nominal)
CA2DF2	2 degree clear diffusion film*
CA2DF85	85 degree frosted diffusion film*
CA2OPF	Opal 2700K warming / frosted diffusion film*
	* actual diffusion depends on selected beam spread

To minimize accessory thickness and thus maximize optical performance, microstructure lenses are utilized in lieu of traditional glass lenses.



### Durability

Calculite LED 1.75" fixtures operating temperatures are well below the recommended thermal limit of each optical accessory, eliminating lens degradation and ensuring maximum optical stability.

Job Information

Type:

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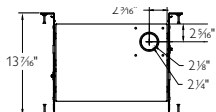
# C2L04

## Calculite 1.75" Aperture, 400 Lumen LED

### Optional Installation Accessories

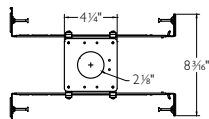
The standard C2L product offering is Non-IC, wet location listed\* with no additional "frame-in kit" required. Listed below are additional frame options.

#### C2LIC



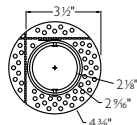
IC frame (new construction).

#### C2LMP



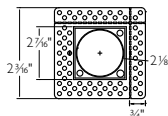
New construction mounting pan provides ability to prelocate wiring for easy below-ceiling access. Includes bar hangers with preset screws which accommodate 12"-24" joist spacing. Bars also attach to T-bar ceilings. Width: 5.5", Length (min): 13.12"

#### CA2FMR



Round aperture flush-mount mud-in ring. Recommended for gypsum applications. Perforated flange allows installation only 1.4" from vertical structure, including corners.

#### CA2X2FMR



Square aperture flush-mount mud-in ring. Recommended for gypsum applications. Perforated flange allows installation only 1.4" from vertical structure, including corners. Square plate secures magnetically to mud-in ring. Tether included.

### Ordering Guide: Installation Accessories

Accessories-Installation	Lumen Package (nominal)
CA2FMR	Round aperture flush-mount mud-in ring*
CA2X2FMR	Square aperture flush-mount mud-in ring*
C2LIC	IC frame (new construction)*
C2LMP	New construction mounting pan*
	* Recommended for specific applications.

Job Information

Type:

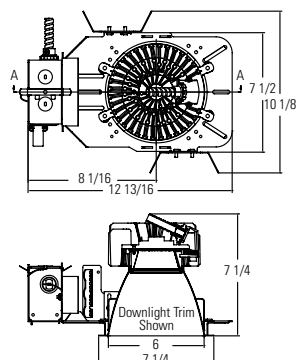
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# Calculite LED Frame-In Kit **C6L15/CUL15**

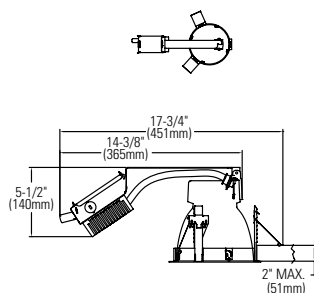
Page 1 of 1

1500 Lumen, 6" Aperture Remote Phosphor LED

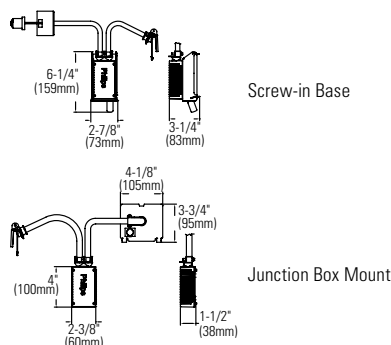
## New Construction Frames



## Remodeler Frames



## Retrofit Frames



## Ordering Guide: Frame-in Kits

Frame-in Kit Series	Installation Options	Input Voltage	Options
<b>C6L15</b> (1500 Lumen)	<b>N</b> (New construction) <b>R</b> (Remodeler)	<b>1</b> (120V) <b>2</b> (277V)	<b>Blank</b> (0-10 volt dimming) <b>EM</b> (Emergency)
<b>CUL15</b> (1500 Lumen)	<b>J</b> (J-box mount retrofit) <b>S</b> (Screw-in base retrofit (120V only))	<b>1</b> (120V) <b>2</b> (277V)	<b>Blank</b> (0-10 volt dimming)

Example: C6L15N1EM

## Features

**Ceiling Cutout:** 6 9/16" (167mm)

**Depth (including Light Engine):** See Light Engine specification sheet for details.

**Power Connection:** Attaches to light engine via push-in connector (on frame). Removable cover provides access.

**Junction Box:** UL listed for 8 No. 12 AWG, 90°C through branch circuit connectors. Allows inspection from below.

**Thermal Protector:** Meets NEC & UL requirements. Do not install insulation above nor within 3" of any part of luminaire.

## New Construction Frame:

**Mounting Frame:** Galvanized stamped steel for dry or plaster ceilings.

**Vertical Adjustment:** Light engine adjusts in frame below ceilings up to 1 1/8".

**Mounting Brackets:** Galvanized Steel. Adjustable through aperture. Use 3/4" or 1 1/2" lathing channel, 1/2" EMT or optional mounting bars.

## Remodeler Frame:

**Power Pack:** Swivel junction box for tight plenum spaces. Snap-off covers permits wiring from top.

**Spring Holder:** Galvanized steel. Accepts up to 2 1/2" (64mm) ceiling thickness.

## Retrofit Frame:

**Capability:** Converts 6" (153mm) or 7" (178mm) Lightolier incandescent frame-in kit without additional wiring using existing Calculite E26 base.

**Socket Cup Support:** Spun steel. Holds Calculite incandescent socket cup.

**Socket Extender:** Phenolic E26 base. Connect to existing lampholder.

## Electrical

Electronic Power Supply: 120 or 277V, 50/60Hz, encased, overload and short circuit protected, thermal regulation to protect against overheating, sound rating "A", -20°C minimum starting temperature, 70°C maximum operating temperature, dimmable with 0-10V dimmer. Dimming compatibility: See LED-DIM specification sheet.

## Electrical (continued)

Input Voltage	Input Frequency	Input Current	LED Drive Current	Input Power	LED Power	THD	Power Factor
120V	50/60Hz	0.25	350mA	27W	23.1W	<1%	>0.9
277V	50/60Hz	0.11	350mA	27W	23.1W	<1%	>0.9

**Rated Life:** 100,000 hours

## Options and Accessories

**Dimming Capability:** 0-10V. See LED-DIM specification sheet

**Emergency Capability (Integral):** Add "EM" suffix. See LED-EM spec sheet.

**Emergency Capability (Inverter):** See LED-LMI specification sheet

**Sloped Ceilings:** See specification sheet SCA.

**Mounting Bars:** 1950-18" Set of (2)

1951-27" Set of (2)

**T-Bar Anchor Clips:** 1956-Set of (4), for use with above

## Labels

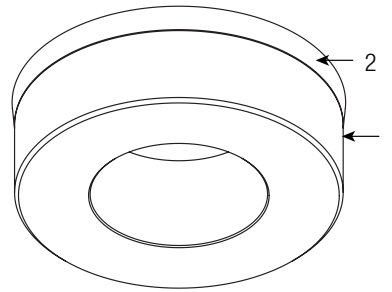
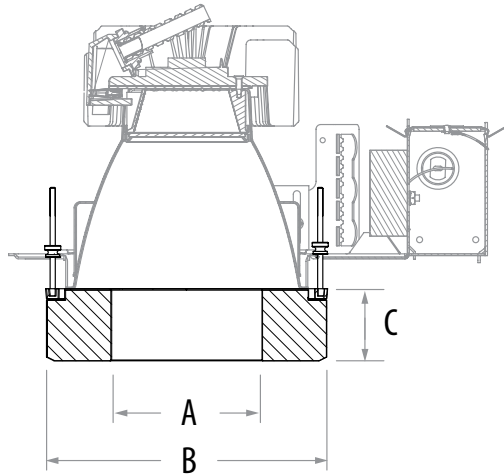
UL, cUL, I.B.E.W.

5 Year Warranty

Job Information	Type:
<b>Job Name:</b>	
<b>Cat. No.:</b>	
<b>Lamp(s):</b>	
<b>Notes:</b>	

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**3 Piece Ordering System:** Complete Fixture consists of Decorative Element, Calculite Light Engine, and Calculite Frame-In Kit. Each sold separately.

Aperture	Decorative Element Catalog No.	Frame-In Kit	Trim	Wattage	Dimensions		
					A	B	C
6"	D6A02	C6L1520 Series	C6L15 Series	27W	4"	7 1/2"	1 7/8"
			C6L20 Series	39W			

### Features

- Decorative Element:** Solid high temp, UV resistant composite with open aperture. Interior diameter is frosted. Polished exterior.
- Die Cast Construction Ring:** Exterior edge of construction ring is visible, satin aluminum finish matches diameter of decorative element for a flangeless appearance.
- Fastener cover:** Stamped aluminum cover ring provided on top of decorative element to cover construction ring fasteners.
- Mounting Frame Fasteners:** Four #8-32 screws and 4 knurled die-cast thumb screws secure construction ring to frame in kit.
- Reflector:** FLANGELESS TRIM REQUIRED. Specified separately. Use Specular Clear (CL) finish for best performance and aesthetics
- Frame-In Kit:** Specified separately. See Trim Specification Sheet for additional details.

### Mechanical

Decorative elements securely fastened to four mounting frame studs.

### Labels

U.L. (Damp Location)

### Job Information

### Type:

**Job Name:**

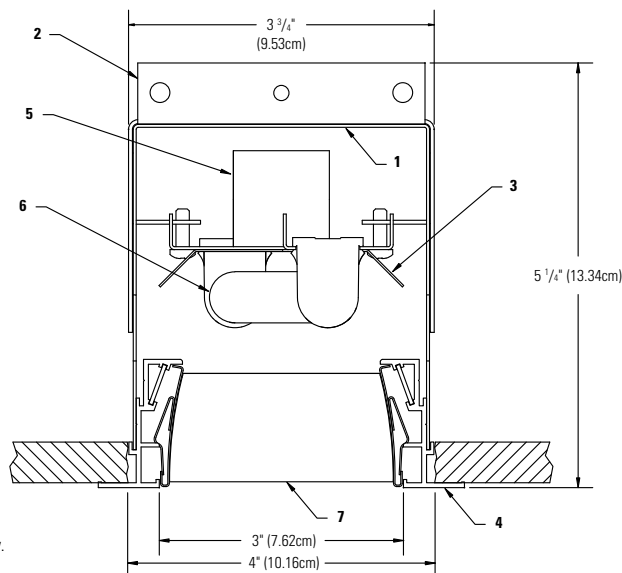
**Cat. No.:**

**Lamp(s):**

**Notes:**

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Complete ordering instructions below.

## Ordering Information

Family	Mounting	Shielding	Configuration	Output	Length (nom.)	Housing	Voltage	Option
<b>CT3</b>	<b>F</b>	<b>P</b>	<b>A</b>					
CT3	F = Flange	P = Parabolic Louver	A = 1 Lamp <sup>1</sup>	H = High Output S = Standard	2 = 2-foot 4 = 4-foot 8 = 8-foot	U = Individ. Unit S = Starter J = Joiner T = Telescoping <sup>2</sup>	1 = 120V 2 = 277V	E = EM Pack <sup>3</sup> T = Tandem Switch 4 = 4 Through Wires 5 = 5 Through Wires D = Dimming

<sup>1</sup> Lamp is mounted diagonally and extends into adjacent fixture by 2-1/2" (6.35cm) in Starter, Joiner and Telescoping fixtures

<sup>2</sup> Telescoping fixture ships 85-3/8" (216.85cm), adjustable down to 49-3/8" (125.41cm)

<sup>3</sup> EM pack not available in 2-foot or Telescoping fixtures

## Features

- Housing:** 20 gauge pre-painted steel
- Bulkhead:** 18 gauge galvanized steel
- Reflector:** semi-specular aluminum
- Trim:** aluminum extruded, flange 3/4" (1.91cm) width
- Ballast:** program start electronic
- Lamp:** T5 or T5 HO fluorescent
- Louver:** semi-specular parabolic, 2-1/4" (5.72cm) nominal blade spacing

## Mounting

Housing is suspended by hanger wires by others.

Optional factory provided Quick-Draw Installation System shown on page 2.

## Electrical

**Electronic Ballast:** Programmed start, 3 conductor, 12 gauge wire.

Color-coded quick connectors allow easy connection for modular fixtures. T5HO lamps are dimmed with Advance Mark 10. T5 standard output lamps are dimmed with ULT Super Dim. Use compatible dimmers and feed wires. Factory installed ballast disconnect allows the ballast to be disconnected from and reconnected to incoming power under load without turning the entire circuit off.

**Emergency Battery Pack:** 450 Lumens @ 90 minimum.

## Labels

UL, cUL and IBEW

## Ordering Instructions

### Individual Fixtures:

- Order number of INDIVIDUAL UNITS required.

### Continuous Rows:

- Determine run length
- Order one Starter fixture
- Order one Telescoping fixture\*
- Order remainder of Joiner fixtures

\* For best one-lamp effect, use Telescoping fixture at longest length possible.

Job Information	Type:
<b>Job Name:</b>	
<b>Cat. No.:</b>	
<b>Lamp(s):</b>	
<b>Notes:</b>	

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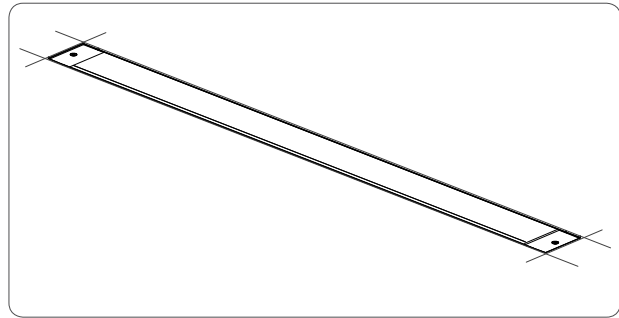
## PROJECT INFORMATION

Project:

Type:

Notes:

REVIT files are available for download at [www.axislighting.com](http://www.axislighting.com)



## PRODUCT ORDERING CODE

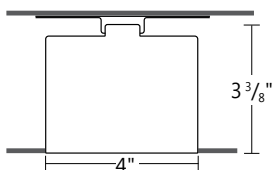
product id	optics lens	length/ft	lamp	lamp config.	finish	voltage	ballast	circuits	power feed	other	controls	custom
<b>WBR</b>			<b>T5</b>									
WBR recessed		2 3 4 5 6 8	T5	1 2 lamp lamps	W white AP alu. paint C custom	UNV 120 277 347* *Please consult factory	ERS D rapid start dimming (specify details)	1 one circuit 2 two circuits +E em. circuit	EF end feed TF top feed	B# battery pack (specify details) F fuse	OS occ. *See Integrated Controls Guide for further details.	C custom (describe below)
	F frosted lens C clear lens S satin lens											

Dimming Ballast, Battery Pack and Integrated Control Details:

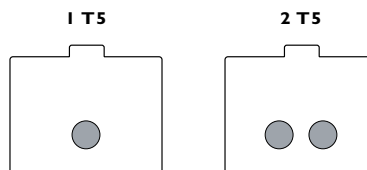
Custom Description:

**i** Specification sheets for other lamping are available for download at [www.axislighting.com](http://www.axislighting.com)

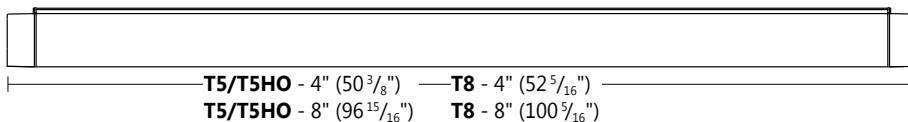
## DIMENSIONS



## LAMPING CONFIGURATIONS



## SIDE VIEW DIMENSIONS



FILE NAME: WBR.T5.SPEC June 30, 2011

Page: 1 / 3

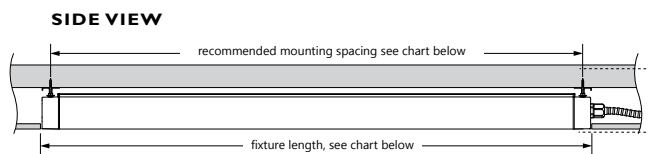
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Product design and development is an ongoing process at Axis Lighting. We reserve the right to change specifications. Contact Axis for the latest product information.

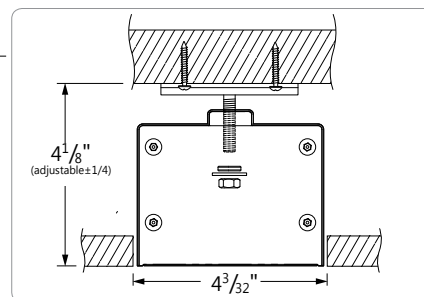
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## ● MOUNTING OPTIONS



WET BEAM LAMPS	MOUNTING SPACING		FIXTURE LENGTH	
	T5/T5HO	T8	T5/T5HO	T8
4'	49"	50 <sup>11</sup> / <sub>16</sub> "	50 <sup>5</sup> / <sub>8</sub> "	52 <sup>5</sup> / <sub>16</sub> "
8'	95 <sup>5</sup> / <sub>16</sub> "	98 <sup>11</sup> / <sub>16</sub> "	96 <sup>15</sup> / <sub>16</sub> "	100 <sup>5</sup> / <sub>16</sub> "

## END VIEW



## ● OTHER MOUNTING OPTIONS

WET BEAM is available with, pendant, surface and wall mounted options.

## ● CONSTRUCTION

<b>Housing</b>	Extruded Aluminum (0.062" nominal) 70% Recycled Content ♻️
<b>End Cap</b>	Die Cast Zinc (0.070" nominal)
<b>Interior brackets</b>	Die Formed Sheet Steel (16 ga)
<b>Gaskets</b>	Moulded Elastomer (0.100" nominal)
<b>Lens Gaskets</b>	Extruded Elastomer (0.045" nominal)
<b>Clear Lens</b>	Extruded Acrylic (0.075" nominal) Clear: 90% transmissive
<b>Frosted Lens</b>	Extruded Acrylic (0.070" nominal) Frosted: 85% transmissive
<b>Satin Lens</b>	Extruded Acrylic (0.070" nominal) Frosted: 68% transmissive
<b>Surface Mounting Brackets</b>	Die Formed Sheet Steel (18 ga)
<b>Lamp Options</b>	T5, T5HO, T8

## ● WEIGHT

4 ft	12.8 lbs / 5.8 Kg
8 ft	24.5 lbs / 11.1 Kg

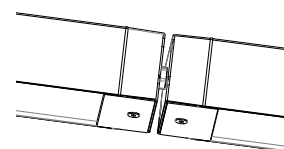
## ● GASKETTED FIXTURE

With it's gasketed end cap and lens the Wet Beam is made for wet locations, it is ideal for exterior soffits and canopies of malls, hospitals and other institutions.

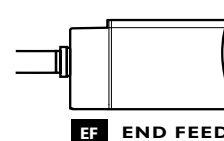
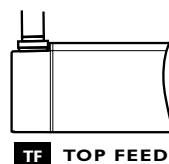
## ● JOINER SYSTEM

Wet Beam modular system consist of smaller modules joined and gasketed together allowing for system runs in lengths of 4' and 8' as well as custom lengths up to 8'.

\* For continuous rows allow 2" for connectors between each fixture.



## ● POWER FEED



## ● FINISH

Aluminium paint, Powder Coated and custom finishes are also available.

## ● ELECTRICAL

<b>Ballast Options</b>	Electronic Rapid Start, Dimming (0-10V, Line, Step, EcoSystem)
<b>Emergency Voltage</b>	Emergency Battery Pack or Circuit 120, 277, 347 2, UNV

## ● APPROVALS

Certified wet locations to UL and CUL standards

**i** Row configuration, specification sheets and mounting spacing guides are available for download at: [www.axislighting.com](http://www.axislighting.com)

FILE NAME: WBR.T5.SPEC June 30, 2011

Page: 2 / 3

ÉCLAIRAGE  
**axis**  
LIGHTING  
1.800.263.AXIS  
[T] 514.948.6272  
[F] 514.948.6271  
[www.axislighting.com](http://www.axislighting.com)



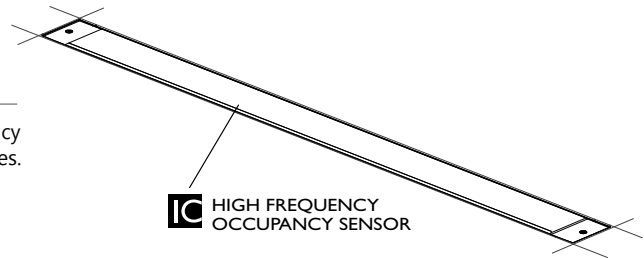
Product design and development is an ongoing process at Axis Lighting. We reserve the right to change specifications. Contact Axis for the latest product information.

© 2010 Axis Lighting Inc.

## ● INTEGRATED CONTROL OPTIONS

WET BEAM luminaires allow the use of integrated controls such as occupancy sensors (OS). These sensors can be seamlessly integrated into our luminaires. The control system could be used to optimize the lighting of the space by reducing energy consumption through occupancy, thereby improving the overall interior environment and allowing for LEED credits.

- Consult factory for other options.
- Refer to IC brochure for more information.



SENSORS	BRAND	Model	TYPE	CODE	COMPATIBLE DIMMING BALLAST
Occupancy Sensor (OS)	Wattstopper	FM-105	High Frequency Occupancy	WH	Programmed Rapid Start

**i** All IES files for other lamping are available for download at: [www.axislighting.com](http://www.axislighting.com)

FILE NAME:WBR.T5.SPEC June 30, 2011

Page: 3 / 3

ÉCLAIRAGE 1.800.263.AXIS  
**axis**  
 LIGHTING [T] 514.948.6272  
 [F] 514.948.6271  
[www.axislighting.com](http://www.axislighting.com)

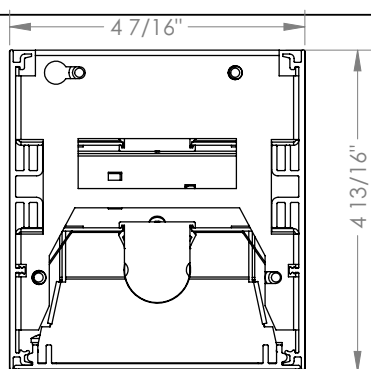


Product design and development is an ongoing process at Axis Lighting. We reserve the right to change specifications. Contact Axis for the latest product information.

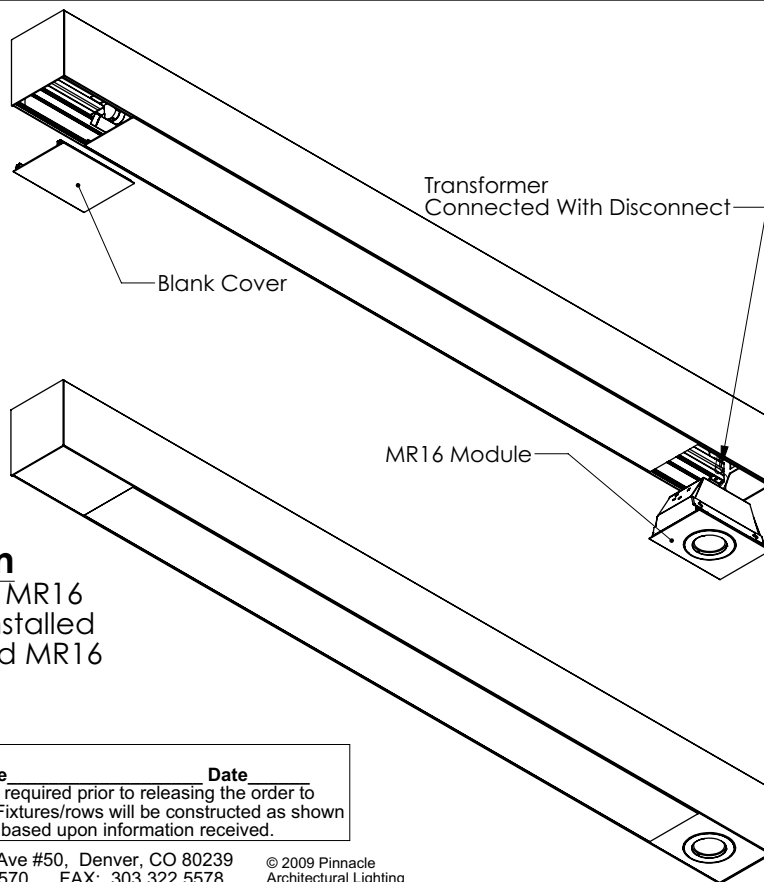
© 2010 Axis Lighting Inc.

# PINNACLE MODIFICATION SPECIFICATION

Date: 9-22-11  
Type: Fixture  
Created By: A. Chronister



End View



## Edge EX4 - MR16 Configuration

Edge EX4 Fixture (Shown as Lens) with MR16 modules that can be removed and installed into blank module locations. Standard MR16 (Non-LED) only.



**PINNACLE**  
ARCHITECTURAL LIGHTING

Signature \_\_\_\_\_ Date \_\_\_\_\_  
Sign-off is required prior to releasing the order to production. Fixtures/rows will be constructed as shown and is based upon information received.

12655 E. 42nd Ave #50, Denver, CO 80239  
PH: 303.322.5570 FAX: 303.322.5578

© 2009 Pinnacle  
Architectural Lighting

CAT:	FEET:
TYPE:	PROJECT:

# TIVOTAPE OUTDOOR™

## STATIC TAPELIGHT

Energy-efficient, low voltage LED tape light strip emits sharp, pure color for unique effects in cove and architectural applications.

### FEATURES

- Flexible waterproof flat conductor strip allows for wide range of installation possibilities
- Ideal for outdoor niche, recessed or borderline lighting
- Full range dimming available
- Sold in 1', 2', 4', 8', 12' and 16' NOM lengths

### SPECIFICATIONS

TIVOTAPE OUTDOOR STATIC	EFFICACY LM/WT	CRI	LM/FT	WT/FT
Red	<b>31.5</b>	n/a	34	1.08
Yellow	27.8	n/a	30	1.08
Green	17.1	n/a	18	1.05
Blue	5.7	n/a	6	1.05
Cool White	<b>32.2</b>	80	37	1.15
Neutral White	29.6	74.6	34	1.15
Warm White	27.0	71.4	31	1.15

Items in bold denote Title 24 High efficacy rating. Measurements are based on 12V DC power design calculations will vary based on power supply and run lengths.

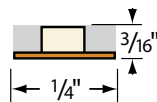
LED DATA	WATTAGE	LED LIFE* / COLOR TEMP	VIEWING ANGLE
Tivotaape Outdoor Static	0.06W per LED	<b>50,000 hrs.</b> Red, Yellow, Green, Blue, Cool White, Neutral White and Warm White	120°

\* LEDs operate at 90% of LED manufacturers maximum current spec rating.

1. **Spacing** - LED spacing:  $\frac{1}{16}$ " O.C.
2. **LEDs** - Uses 18 LEDs per strip
3. **Mounting** - Includes installation-ready 3M tape adhesive for simplified installation
4. **Installation** - Optional clear and frosted tube and channel available for architectural effects
5. **Field Trimmable** - See Page 3 for cut zones
6. **Power Supply** - Listed Class II 12V DC power supply required
7. **Listing** - UL listed File #E321933  
- IP65 Outdoor rated
8. **Compliance** - ROHS Compliant
9. **Warranty** - 3 Year Warranty

cULus **IP65**

### PROFILES



### TIVOTAPE STATIC TAPE LIGHT ORDER SPECIFICATION GUIDE

Example: TPL-O-CWH-1-MD-12

PRODUCT CODE	INSTALL	LED COLOR	LENGTH	ENDPREP	VOLTAGE	REQUIRED POWER SUPPLY
TPL	O				12	PSU
Tivotaape Static™	O = Outdoor	RED = Red YEL = Yellow GRN = Green BLU = Blue CWH = Cool White (6000°K +/-300°K) NWH = Neutral White (4100°K +/-300°K) WWH = Warm White (3000°K +/-300°K)	1 = 1 foot 2 = 2 foot 4 = 4 foot 8 = 8 foot 12 = 12 foot 16 = 16 foot	MD = Male/Dead End MF = Male/Female	12 = 12V DC	See power supply specsheets

### REQUIRED POWER SUPPLY OPTIONS

- ☐ ADUL-75-1-5-12-D
- ☐ ADUL-200-3-5-12-D
- ☐ ADNM-75-1-5-12-D
- ☐ ADNM-200-3-5-12-D
- ☐ JT-60-1-5-12-D
- ☐ JTH-60-1-5-12-D
- ☐ JT-240-4-5-12-D
- ☐ JTH-240-4-5-12-D
- ☐ HS-20-1-1.5-12-D
- ☐ HS-40-1-3.3-12-D

See power supply specifications for more information

### OPTIONAL DIMMERS

- ☐ N-600
- ☐ N-1000
- ☐ NH-600
- ☐ NH-1000
- ☐ DIM-12V-8A
- ☐ DIM-OT-1-5-D



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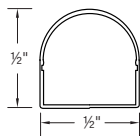
# TIVOTAPE OUTDOOR™ STATIC TAPELIGHT

## MOUNTING ACCESSORIES

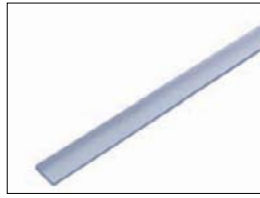
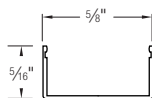


**TPL-TUBE-C/F-8** Architectural Tube  
Available Clear or Frosted in 8' standard lengths, one piece Tivotape architectural tube is recommended for uneven mounting surfaces or applications that require straight and uniform orientation of LED's while adding protection from physical access. Can be mounted to TPL-TUBE-BASE-8 channel or directly to surface via double sided tape.

**TPL-TUBE-EC** Architectural Tube End Cap



**TPL-TUBE-BASE-8** Architectural Tube Mounting Channel can be used with the Architectural Tube or mounted directly to Tivotape.  
Available Clear or Frosted in 8' standard lengths.

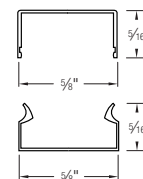


**TPL-STRIP-1** Mounting strip  
Available in 11 1/4" standard lengths. Tivotape mounts to the mounting strip to provide a flat rigid mount inside the Architectural tube or on it's own. Also recommended when mounting onto metal surfaces.



**TPL-INF-C/F-CHAN-8** Infinity Channel  
Available Clear or Frosted in 8' standard lengths, two piece Infinity mounting channel is recommended for uneven mounting surfaces or applications that require very straight and uniform orientation of LED's while adding protection from physical access. The Infinity mounting channel allows a wide beam spread from the mounting surface while maintaining a small over-all foot print.

**TPL-INF-EC** Infinity Channel End Cap



## WIRING ACCESSORIES



**TPL-LEAD-0-2-01/16** Lead Wire  
2 conductor static lead wire available in 1' or 16' standard lengths. Features 24 gauge wire on input end and 2 pin static connection on other end.

**TPL-CONN-0-2-1** Connector

1' Male/Female connector

**TPL-CONN-0-2-2** Connector

2' Male/Female connector

**TPL-CONN-0-2-4** Connector

4' Male/Female connector

**TPL-CONN-0-2-16** Connector

16' Male/Female connector

## MTBF

**Mean Time Between Failures (MTBF) for LEDs:** While Tivoli utilizes LEDs provided by industry leading vendors, these are electrical components with calculated manufacturers mean time between failures (MTBF). MTBF is rated as the average point at which 1/2 of color LEDs will lose 50% of their original brightness. MTBF for White LEDs is based on when 1/2 are reduced to 70% of their original brightness.

Typically, LED product failures occur within fixture construction, interdependent component failure, or operation under adverse conditions. Tivoli operates LEDs at a derated current to insure that LED MTBF values are based on product fixture construction and real application standards.

Still, conditions such as excessive voltage, vibration, heat, and other adverse conditions may negatively effect the life of LEDs.



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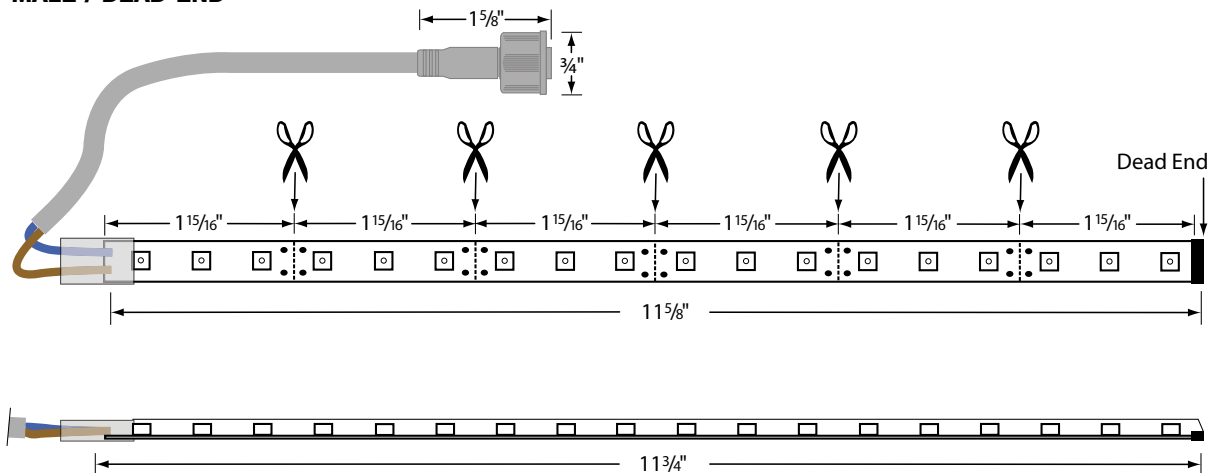
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# TIVOTAPE OUTDOOR™ STATIC TAPELIGHT

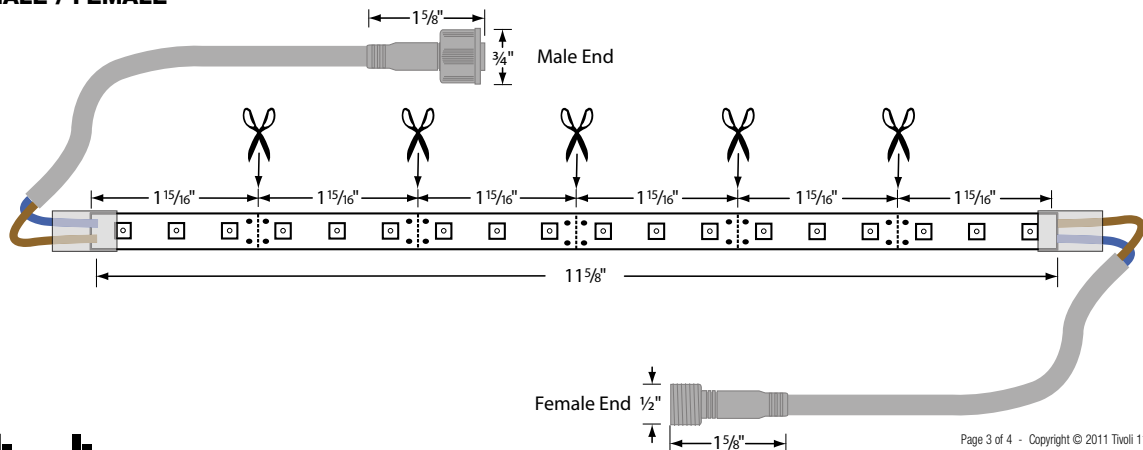
CAT.NO	COLOR	VIEWING ANGLE	WAVELENGTH (COLOR TEMP)	WATTS PER FOOT	LUMENS PER FOOT	LUMENS PER WATT	LEDS PER FOOT	MAX LEDS PER 5A CIRCUIT*	MAX CONTINUOUS RUN
TPL-0-RED-1-12	Red	120°	625nm	1.08W	34	31.48	18	870 (50ft.)	470 LED's (27ft)
TPL-0-YEL-1-12	Yellow	120°	589nm	1.08W	30	27.78			
TPL-0-GRN-1-12	Green	120°	515nm	1.05W	18	17.14			
TPL-0-BLU-1-12	Blue	120°	470nm	1.05W	6	5.71			
TPL-0-CWH-1-12	Cool White	120°	5000-10000°k	1.15W	37	32.17		800 (46ft.)	450 LED's (26ft)
TPL-0-NWH-1-12	Neutral White	120°	3700-5000°k	1.15W	34	29.57			
TPL-0-WWH-1-12	Warm White	120°	2600-3700°k	1.15W	31	26.97			

\* Based on 2.5A continuous run

## PROFILE MALE / DEAD-END



## PROFILE MALE / FEMALE



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# TIVOTAPE OUTDOOR™ STATIC TAPELIGHT

## RECOMMENDED POWER SUPPLIES

PART #	PRIMARY AND SECONDARY	TOTAL WATTAGE / AMPERAGE PER BREAKER	LISTING	DIMENSIONS	WEIGHT	ELECTRONIC OR AC MAGNETIC	DIMMABLE (Y OR N)
ADUL-75-1-5-12-D	85-264V AC / 12V DC	75 / 1X5A	UL/ETL	10"W X 10"L X 4"D		Electronic	Y: C & D
ADUL-200-3-5-12-D	85-264V AC / 12V DC	200 / 3X5A	UL/ETL	10"W X 10"L X 4"D		Electronic	Y: C & D
ADNM-75-1-5-12-D	85-264V AC / 12V DC	75 / 1X5A	UL/ETL	10"W X 10"L X 4"D		Electronic	Y: C & D
ADNM-200-3-5-12-D	85-264V AC / 12V DC	200 / 3X5A	UL/ETL	10"W X 10"L X 4"D		Electronic	Y: C & D
JT-60-1-5-12-D	120V AC / 12V DC	60 / 1X5A	ETL	4.25"W X 8.50"L X 3.25"D		Magnetic	Y: A, B, C & D
JTH-60-1-5-12-D	277V AC / 12V DC	60 / 1X5A	ETL	4.25"W X 8.50"L X 3.25"D		Magnetic	Y: C, D, E & F
JT-240-4-5-12-D	120V AC / 12V DC	240 / 4X5A	ETL	8.50"W X 16.00"L X 4.50"D		Magnetic	Y: A, B, C & D
JTH-240-4-5-12-D	277V AC / 12V DC	240 / 4X5A	ETL	8.50"W X 16.00"L X 4.50"D		Magnetic	Y: C, D, E & F
HS-20-1-1.5-12-D	120-240V AC / 12V DC	75 / 1X1.5A	UL	1.60"W X 3.80"L X 1.00"D		Electronic	N
HS-40-1-3.3-12-D	120-240V AC / 12V DC	200 / 1X3.3A	UL	3.60"W X 2.75"L X 1.25"D		Electronic	N

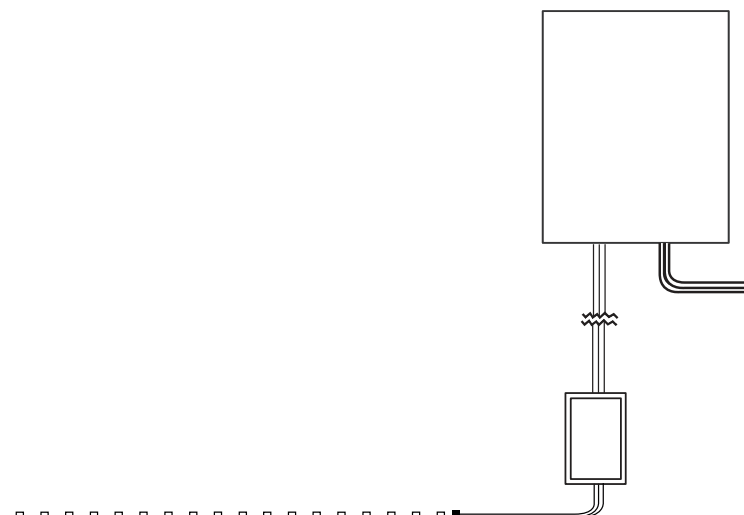
## DIMMERS

SELECTOR	DIMMER	TYPE	CONTROL SIGNAL	INPUT VOLTAGE	OUTPUT VOLTAGE	MAX LOAD	BREAKER RATING	DIMENSIONS
A	N-600	AC Magnetic	N/A	120V AC	120V AC	450W Max.	N/A	Recessed Single gang box
B	N-1000	AC Magnetic	N/A	120V AC	120V AC	800W Max.	N/A	Recessed Dual gang box
C	DIM-12V-8A	DC Digital	N/A	12V DC	12V DC	96W	8A*	Single gang box
D	DIM-OT-1-5-D	Control Interface	1-10VDC	12V DC	12/24V DC	60W	5A**	7"L X 1½"W X ¾"H
E	NH-600	AC Magnetic	N/A	277V AC	277V AC	450W	N/A	Recessed Single gang box
F	NH-1000	AC Magnetic	N/A	277V AC	277V AC	800W	N/A	Recessed Dual gang box

\*\*OTDIM applications require 1 each OTDIM per 5 amp circuit

## PRODUCT SPECIFICATION GUIDE

LIGHT SOURCE	MAX CONTINUOUS RUN LENGTH
Red, Yellow, Green, Blue	27ft
Whites	26ft



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JULY 16, 2012

LIGHTING CATALOG PAGE

THE LIGHTING DESIGN ALLIANCE, INC.

LOS ANGELES  
2830 TEMPLE AVENUE  
LONG BEACH, CA 90806-2213

T: 562.989.3843  
F: 562.989.3847  
[www.LightingDesignAlliance.com](http://www.LightingDesignAlliance.com)

TYPE  
**SD1, SD2**  
4 of 4



# SN SERIES SN STRIP

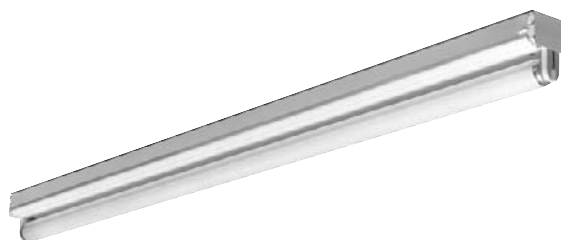
Page 1 of 2

NARROW WIDTH CHANNEL

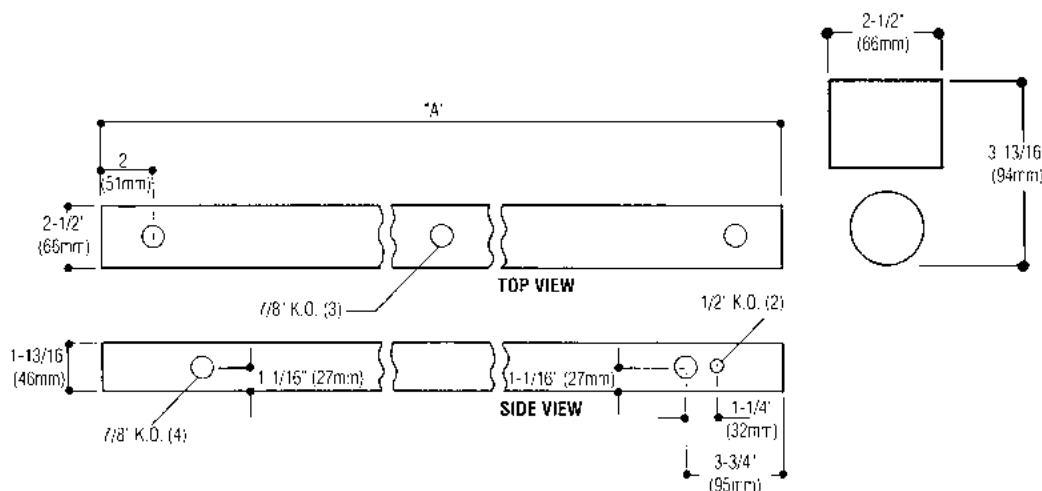
2 1/2" WIDE x 1 13/16" DEEP x 18", 24", 36", 48", 72", 96" LENGTHS, ONE LAMP, T8 OR T12

## Features

- Fixtures suitable for individual, row, surface, or suspension mounting.
- Efficiency 94% (T8).
- Quarter turn latch secures channel cover for easy wireway access.
- Heavy duty channel of code gauge die formed steel.
- Only 2-1/2" wide.
- Fully enclosed wiring.
- U.L. Listed snap-on end caps.
- Combination end cap for continuous row mounting.
- Green grounding screw installed in channel.
- UL listed for direct mounting on low density ceilings and damp locations.



## Dimensions



DIMENSIONS		
"A"		
Channel Length	Inches	(mm)
18" Channel	18"	(457 mm)
24" Channel	24"	(610 mm)
36" Channel	36"	(914 mm)
48" Channel	48"	(1219 mm)
72" Channel	72"	(1829 mm)
96" Channel	96"	(2438 mm)

## Job Information

Type:

Job Name:

Cat. No.:

Lamp(s):

Volts/Ballast:

Lightolier a Genlyte Thomas Company [www.lightolier.com](http://www.lightolier.com)  
 Technical Information: (978) 657-7600 • Fax (978) 658-0595  
 631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710  
 We reserve the right to change details of design, materials and finish.  
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 A0902

SECTION 3A/Folio H110-40

LIGHTOLIER®



# SN SERIES SN STRIP

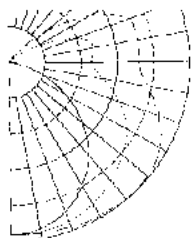
Page 2 of 2

NARROW WIDTH CHANNEL

2 1/2" WIDE x 1 13/16" DEEP x 18", 24", 36", 48", 72", 96" LENGTHS, ONE LAMP, T8 OR T12

## PHOTOMETRY

REPORT NO: G14444  
CATALOG NO:  
SN4S132HPF120SO  
LAMP TYPE, F32 / T8  
LUMENS PER LAMP: 2900  
TOTAL EFFICIENCY 94%  
CIC TYPE: SEMI-DIRECT  
SPACING CRITERIA: 1.6  
SHIELDING ANGLE 180

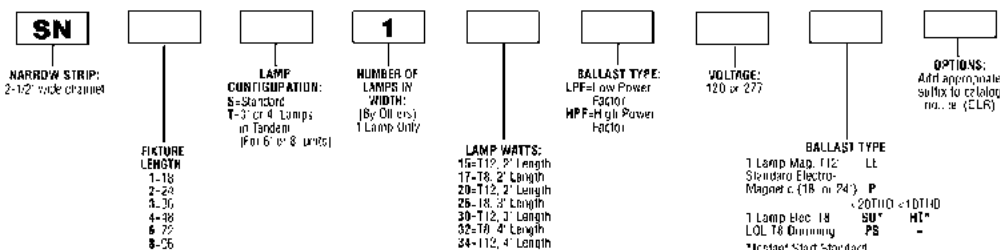


LER - FS - 68.7 Watts - 36 BF - 0.88  
Comparative yearly lighting energy cost per 1000 lumens = \$3.29

coefficients of utilization — zonal cavity method

RF	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
RC	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
FW	70	50	39	30	23	18	14	11	9	7	6	5	4	3	2	1	0
Room Cavity Ratio	1	94	98	83	75	72	68	68	65	62							
2	84	75	67	61	58	53	57	53	49								
3	76	65	56	55	48	43	50	46	40								
4	69	56	47	48	41	36	45	38	33								
5	63	50	41	43	36	31	41	34	29								
6	58	45	36	38	31	26	35	29	24								
7	53	40	31	35	28	23	31	26	21								
8	50	36	28	32	25	20	29	23	19								
9	46	33	25	29	22	18	26	21	17								
10	43	30	23	27	21	16	24	19	15								

## ORDERING INFORMATION Explanation of Catalog Number Example: SN4S130LPF120S0GLR



Offer dimming options. Consult factory.

## OPTIONS/ACCESSORIES

**FUSING:** Internal fast-blow fusing. SUFFIX: **GLR**. Internal slow-blow fusing. SUFFIX: **GMF**.

**RADIO INTERFERENCE FILTER:** 120 or 277 volt, 50 or 60 Hz. One per fixture is standard. SUFFIX: **RF**.

**FLUORESCENT EMERGENCY LIGHTING SYSTEM:** Factory-installed emergency power battery pack with charger and inverter. SUFFIX: **EM**.

**STEM AND CANOPY SETS:** Suspends fixture 6", 12", 18" or 24" from surface. (Four per fixture is recommended.) Catalog Number: **ASC6 CSP** (6"), **ASC12 CSP** (12"), **ASC18 CSP** (18"), **ASC24 CSP** (24")

**CANOPY SPACER:** Suspends fixture 1-1/2" from surface. Order Catalog

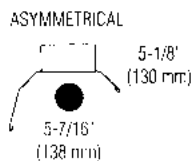
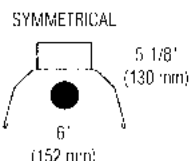
Number: **AC1 CSP**

**GROUND CONVENIENCE OUTLET:** 120 volt only. SUFFIX: **CO**.

**4" WIRE GUARD:** Catalog Number: **AWG1W CSP**.

**REFLECTORS:** Order Catalog Number:

**SYMMETRICAL:** NSYMC20 CSP (24")  
NSYMC30 CSP (36")  
NSYMC40 CSP (48")  
**ASYMMETRICAL:** NASYC20 CSP (24")  
NASYC30 CSP (36")  
NASYC40 CSP (48")



## SPECIFICATIONS

**MATERIALS:** Chassis parts are die-formed heavy gauge cold rolled steel, 1-13/16" deep x 2-1/2" channel width.

**BALLAST COVER:** Code gauge steel secured with 1/4" turn fasteners.

**FINISH:** Chassis exterior phosphate undercoating, baked white polyester enamel.

**ELECTRICAL:** Thermally protected class "P" ballast C.B.M. approved, non-PCB. If K.O. is within 3" of ballast, use wire suitable for at least 90°.

**LABELS:** I.B.E.W./UL and UL Listed.

## Job Information Type:

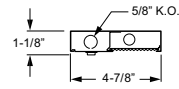
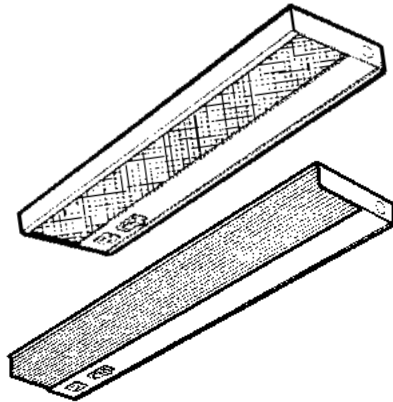
Lightolier a Genlyte Thomas Company www.lightolier.com  
Technical Information: (978) 657-7600 • Fax (978) 658-0595  
631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710  
We reserve the right to change details of design, materials and finish.  
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A0902 SECTION 3A/Folio H110-40

LIGHTOLIER®

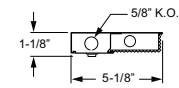
## 1-1/8" DEEP T5 UNDER CABINET

SERIES **1SF**  
**TWO**

VOLTAGE TYPE JOB



ISF Solid Front



TWO Wrap-around Opal

## SPECIFICATIONS

- HOUSING – 20-gauge die-formed, welded C.R.S.
- SHIELDING – 1SF: Flat, clear acrylic prismatic lens. TWO: High-impact, extruded white opal acrylic lens.
- FINISH – 92% minimum average reflective white polyester powder coat bonded to multi-stage, pretreated, conversion coated metal.
- ELECTRICAL – T5 pre-heat ballast with built-in electronic starter or program rapid start (dependent upon lamp—consult factory), rated Class P.
- MOUNTING – Surface.
- LABELS – UL/CUL listed as fluorescent luminaire suitable for dry or damp locations.

## FEATURES

- Small profile allows inconspicuous placement in confined spaces.
- Provides uniform, glare-free illumination of task area.
- Housing keyhole slots and knockouts provide quick and easy installation.
- Individual or continuous row mounting.
- Optional anti-microbial powder coating available to prevent the spread of dangerous micro-organisms and suppress the growth of mold and bacteria.
- All-welded construction provides long lasting performance.
- All parts painted after fabrication to facilitate installation, increase efficiency, and inhibit corrosion.
- This fixture is proudly made in the USA.

## ORDERING INFORMATION

Submit

EXAMPLE: SERIES **1SF** - NOM. LENGTH **24** - TOTAL LAMPS **2** - WATTAGE/TYPE **08T5P** - SHIELDING (1SF ONLY) **A12125** - OPTIONS **EB2** - BALLAST TYPE **EB2** - VOLTAGE **120**

## SERIES

**1SF** Solid Front  
**TWO** Wrap-around Opal

## NOMINAL LENGTH

**T5S**  
**2** 2'  
**3** 3'  
**4** 4'

## T5P

**12** 12"  
**21** 21"  
**24** 24"  
**33** 33"  
**42** 42"

## TOTAL LAMPS (1-lamp cross-section only)

**1**  
**2** (T5P, tandem only)

## LAMP WATTAGE/TYPE

**T5S**  
**14T5S** 2', 14-watt T5  
**21T5S** 3', 21-watt T5  
**28T5S** 4', 28-watt T5

## T5P

**08T5P** 12", 8-watt preheat T5  
(2-lamp tandem available for 24")  
**13T5P** 21", 13-watt preheat T5  
(2-lamp tandem available for 42")  
**138T5P** (1) 21", 13-watt and (1) 12", 8-watt preheat T5 (tandem)

## SHIELDING (1SF only)

**A12125** #12 pattern acrylic, .125" thick  
**KSH-25/A** Linear ribbed acrylic for wide distribution, .110" thick  
**KSH-25/B** Perpendicular ribbed acrylic for focused distribution, .110" thick

**Note:** For more options/accessories, ballast combinations, and product details, please consult factory.

## OPTIONS

**GCO** Grounded convenience outlet (120V only)  
**C&P/120** 6-1/2" cord and plug, NEMA 5-15P (120V only)  
**WRS** White rocker switch (120V only)  
**AMW** Anti-microbial white finish

## BALLAST TYPE

**EB1** 1-lamp electronic ballast  
**EB2** 2-lamp electronic ballast

## VOLTAGE

**120** 120V  
**277** 277V  
**UNV** 120-277V  
**347** 347V



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Surface Mount Page 24

# ISF IWO

SERIES

## PHOTOMETRY INFORMATION

Williams Catalog #ISF-24-208T5P

Lamp Type: F8T5/CW

Test Report #7967.0, Dated 06/29/94

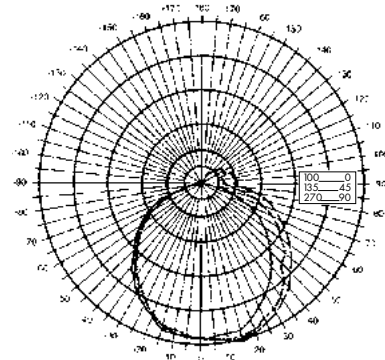
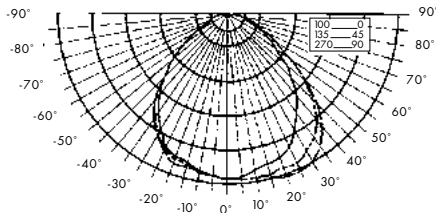
Lamp Quantity: 2

Williams Catalog #IWO-24-208T5P

Lamp Type: F8T5/CW

Test Report #7966.0, Dated 06/29/94

Lamp Quantity: 2



### LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% FIXTURE
0 - 30	155.	19.9	32.0
0 - 40	255.	32.7	52.6
0 - 60	414.	53.1	85.6
0 - 90	484.	62.1	100.0
90 - 120	0.	.0	.0
90 - 130	0.	.0	.0
90 - 150	0.	.0	.0
90 - 180	0.	.0	.0
Total Luminaire 0-180	484.	62.1	100.0

### LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% FIXTURE
0 - 30	113.	14.5	24.0
0 - 40	185.	23.7	39.4
0 - 60	325.	41.7	69.1
0 - 90	434.	55.6	92.2
90 - 120	25.	3.2	5.3
90 - 130	31.	3.9	6.5
90 - 150	36.	4.6	7.6
90 - 180	37.	4.7	7.8
Total Luminaire 0-180	471.	60.3	100.0

**TOTAL LUMINAIRE  
OPTICAL EFFICIENCY = 62.1 %**

**TOTAL LUMINAIRE  
OPTICAL EFFICIENCY = 60.3 %**

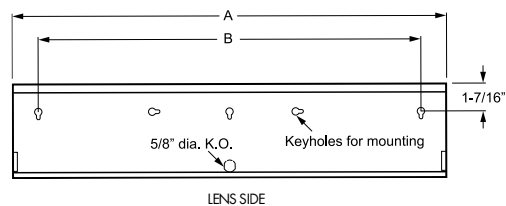
### BACK VIEW

CATALOG NO.	DIMENSION	
	A	B
ISF-12-108T5P or IWO-12-108T5P	12-1/8"	7-1/2"
ISF-21-113T5P or IWO-21-113T5P	21-1/2"	17"
ISF-24-208T5P or IWO-24-208T5P	24-1/2"	20"
ISF-2-214T5S or IWO-2-114T5S	22-5/8"	20"
ISF-33-138T5P or IWO-33-138T5P	33-1/2"	29"
ISF-3-121T5S or IWO-3-121T5S	34-3/8"	29"
ISF-42-213T5P or IWO-42-213T5P	42-1/2"	38"
ISF-4-128T5S or IWO-4-128T5S	46-1/4"	38"

5/8" dia. K.O.



ENDVIEW



LENS SIDE

Back of housing provided with adequate keyhole slots  
and K.O. for mounting and wiring.



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Information contained herein is subject to change without notice.

HEWJP43626 09/02/11RJ

# AJ Eklipta Wall/Ceiling

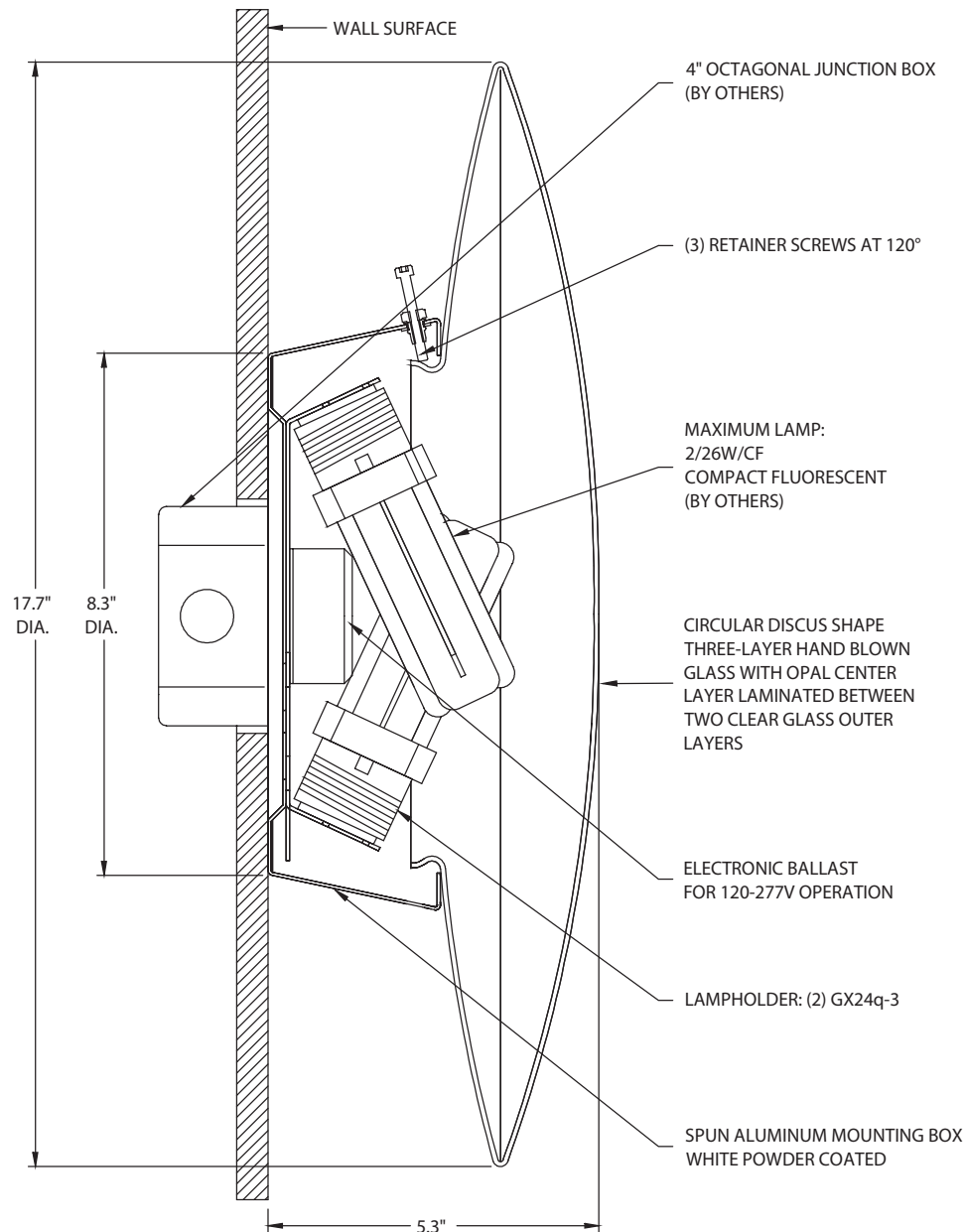
Design: Arne Jacobsen

17.7"-2-26W-CF

Type:

Project:

Catalog Number:

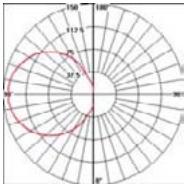


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poulsen**

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Telephone: (954) 349-2525 Fax: (954) 349-2550 [www.louispoulsen.com](http://www.louispoulsen.com)



# AJ Eklipta Wall/Ceiling



Photometric Report: AJE-1-40W-INC.IES  
 Report No.: L4662  
 Poulsen Report No.: AJE-1-40W-INC.IES  
 Luminaire: AJE-1-40W-INC  
 Lamp: 1/40W/G9/Halogen  
 Efficiency: 67.5%  
 Description: All data shown are per 1000 lumens. This report can be used for calculation on all versions listed below. Use only actual lumen data when calculating.

Candlepower Distribution

Vertical Angle	Candela
0	18
5	22
15	35
25	56
45	98
55	114
75	137
85	142
90	142
105	138
125	117
145	80
165	26
180	2

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0-30	23	2.3	3.4
0-40	48	4.8	7.1
0-60	133	13.3	19.7
0-90	335	33.5	49.7
90-120	204	20.4	30.2
90-130	264	25.4	37.6
90-150	317	31.7	47.0
90-180	340	34.0	50.3
0-180	675	67.5	100.0

Weblink: 107

Design: Arne Jacobsen

Light Concept: The fixture emits soft comfortable light. The glass is designed to provide a uniformly lit surface. The three-layer hand-blown opal glass shade has a transparent edge, providing a decorative halo of light around the fixture.

Finish: White, powder coated. White opal glass.

Material: Ceiling/Wall box: Spun aluminum. Diffuser: Handblown white opal glass.

Mounting: Surface: Mounted directly to finished surface over a recessed 4" octagonal junction box.

Weight: Max. 6 lbs.

Label: cULus, Damp location, Wet location. IBEW.

Product code	Dimension	Light source	Voltage	Finish	Mounting
AJE	8.7" 13.7" 17.7"	1/18W/CF GX24q-2 2/18W/CF GX24q-2 2/26W/CF GX24q-3 1/60W/A-19/IF medium 1/100W/A-19/IF medium 1/40W/T-4/IF G9	120-277V 120V	WHT	WALL AND CEILING WALL

Specification notes:

- a. 8.7" variant only available in 1/40W/T-4/IF G9.
- b. 13.7" variant available in 1/18W/CF or 1/60W incandescent.
- c. 17.7" variant available in 2/26W/CF, 1/100W incandescent or 2/18W/CF.
- d. 2/26W/CF variant only available for wall mounting.
- e. CF variants provided with one 120-277V electronic ballast.
- f. Incandescent variants only available in 120V.

Info notes:

- I. The comparable EU version has the following classification: Ingress Protection Code: IP44.



# SPECIFICATION SHEET

**lumenbeam™**

MEDIUM  
WHITE & STATIC COLORS

Client: \_\_\_\_\_  
Project name: \_\_\_\_\_  
Order #: \_\_\_\_\_  
Type: \_\_\_\_\_ Qty: \_\_\_\_\_

## FEATURES AND BENEFITS

### Physical :

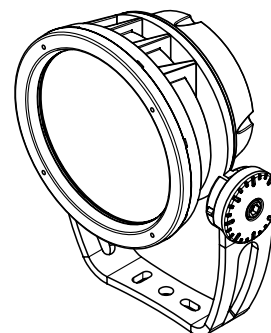
- Low copper content high pressure die-cast aluminum housing
- Heavy aluminum formed yoke (standard yoke included)
- Stainless steel hardware
- Silicone sealing devices
- Clear tempered glass
- Dual chamber design for heat management and ease of maintenance
- Electro-statically applied polyester powder coat finish
- 3.05 kg / 6.7 lbs
- IP66
- EPA: Front = 0.46 sq. ft. Side = 0.37 sq. ft.

### Performance :

- Minimum 1fc (10.7 lux) @ 238 feet (72.5m) distance (4000K, 6° optic)
- 1,400 delivered lumens and 56,521 candelas at nadir (4000K, 6° optic)
- 6°, 10°, 20° or 40°, Elliptical distribution on 10° and 40° optics
- Lumen maintenance L70 @ 25°C - 120,000 hrs
- Lumen measurements comply with LM - 79 - 08 standard
- Operating temperatures : -25°C to 50°C

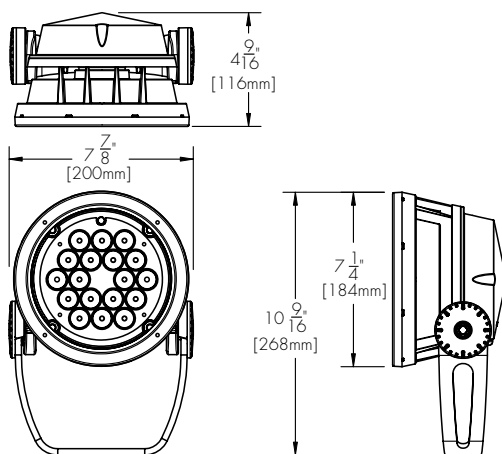
### Electrical :

- Line voltage luminaire for 120 to 277V
- Power and data in 1 cable, 3ft cord (#16-5)
- 27 watts
- 0-10 volt, DMX or DALI dimming options

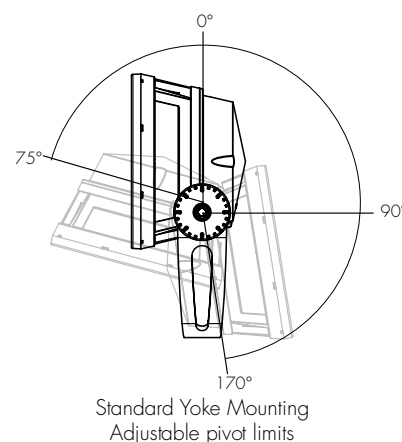


### Wiring detail

WIRE COLOR / USE	
GREEN	GROUND
WHITE	NEUTRAL
BLACK	LIVE 120-277V
RED	0-10V / DATA +
ORANGE	0-10V / DATA -



Standard Yoke (as shown, included)



5 year warranty

1/11

Lumenpulse, 1751 Richardson, Suite 1505, Montreal (Quebec) Canada H3K 1G6 1.877.937.3003 P. 514.937.3003 F. 514.937.6289  
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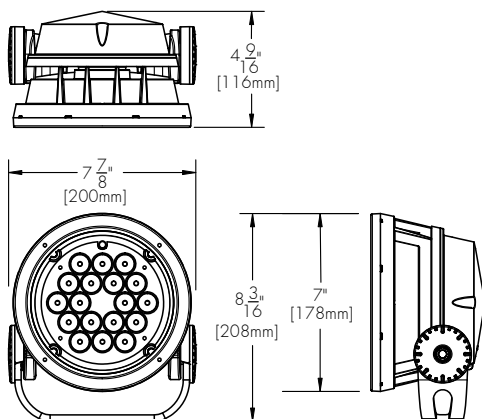
TYPE  
**WD1**  
1 of 2

# SPECIFICATION SHEET

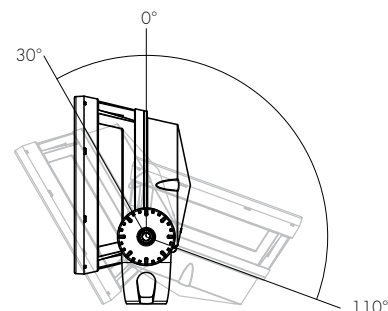
**lumenbeam™**

MEDIUM  
WHITE & STATIC COLORS

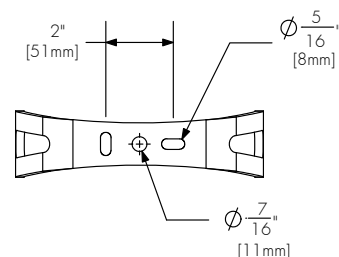
## MOUNTING OPTIONS



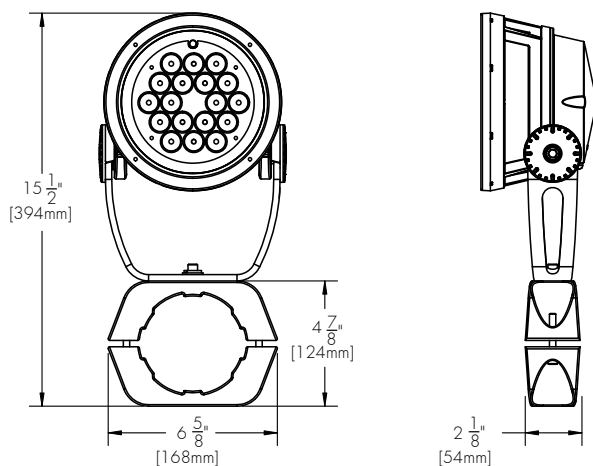
**SY**  
Short Yoke Mounting



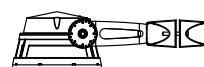
Short Yoke mounting  
adjustable pivot limits



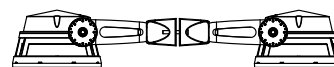
Standard and Short Yoke mounting  
holes pattern



**PM**  
Round Pole Mounting Accessory  
\*Consult factory for square pole section



**PM4-1, PM4.5-1, PM5-1**  
Round Pole Mounting accessory  
single fixture



**PM4-2, PM4.5-2, PM5-2**  
Round Pole Mounting accessory  
twin fixtures

When **PM4-2, PM4.5-2 or PM5-2** are specified,  
one bracket assembly is supplied per 2 fixtures unless  
otherwise specified.

2/11

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[www.LightingDesignAlliance.com](http://www.LightingDesignAlliance.com)

TYPE  
**WD1**  
2 of 2



## Recessed wall luminaires with directed light

**Housing:** Constructed of die-cast and aluminum with integral wiring compartment. Mounting tabs provided.

**Enclosure:** One piece die-cast aluminum faceplate. Clear tempered glass; .125" thick, machined flush to faceplate surface. Faceplate is secured by two (2) flush, socket head, stainless steel captive screws threaded into stainless steel inserts in the housing casting. Continuous high temperature, molded silicone rubber gasket for weather tight operation.

**Electrical:** Provided with a quantity of ten (10) 1 W LEDs, 14.5 total system watts, -30° C start temperature. Integral 120V or 277 V electronic driver. The LED board and the driver are mounted on a removable plate for easy replacement. LED color temperature is 3300K. Junction temperature is 74 °. Dimming driver (120V) is available, please consult factory.

**Note:** Due to the dynamic nature of LED technology, LED luminaire data on this sheet is subject to change at the discretion of BEGA-US. For the most current technical data, please refer to [www.bega-us.com](http://www.bega-us.com).

**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. Protection class: IP65.

Type:  
BEGA Product:  
Project:  
Voltage:  
Color:  
Options:  
Modified:



		Lamp	Lumen	A	B	C
<b>2384 LED</b>	ADA	10W LED	840	12½	2¾	2½



**BEGA-US** 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 FAX (805) 566-9474 [www.bega-us.com](http://www.bega-us.com)  
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# RECESSED LYTESPOT

Page 1 of 3



Specification and Ordering Information:

TYPE:

## 1. Style:

☐

- ☐ RCST - Recessed with trim (RCST)
- ☐ RCS - Recessed trim-less (RCS)

## 2. Lamp Quantity:

☐

- ☐ 1
- ☐ 2
- ☐ 3

## 3. Downlight Options:

☐

- ☐ MR16: 1x 50 Watt MR16 Halogen (MR16)
- ☐ AR111: 1 x 50/75 Watt AR111 Halogen (AR111)
- ☐ PAR30: 1 x 50/75 Watt Par 30 Halogen (PAR30)
- ☐ S08220: 1 x 22 Watt CDM20 TM BT-5 (S08220)
- ☐ S08235: 1 x 35 Watt CDM35 TM BT-5 (S08235)
- ☐ S11139: 1 x 39 Watt CDM35 TC-T4 (S11139)
- ☐ S11170: 1 x 70 Watt CDM70 TC-T4 (S11170)
- ☐ GX1020: 1 x 20 Watt CMH20/MR16 (GX1020)
- ☐ GX1039: 1 x 39 Watt CMH39/MR16 (GX1039)
- ☐ PAR2039: 1 x 39 Watt CDM35/PAR20 (PAR2039)
- ☐ PAR3039: 1 x 39 Watt CDM35/PAR30L (PAR3039)
- ☐ PAR3070: 1 x 70 Watt CDM70/PAR30L (PAR3070)
- ☐ R11135: 1 x 35 Watt CDM-R111/35 (R11135)
- ☐ R11170: 1 x 70 Watt CDM-R111/70 (R11175)
- ☐ LEDAR111: 1 x 14W Watt AR111-LED 3000K (LEDAR111)
- ☐ CZEN13: Citizen® 1 x 13W Watt LED Module, 950LM, 80CRI, 3000K (CZEN13)
- ☐ CZEN13-0-10V: Citizen® 1 x 13W Watt LED Module, 0-10V Dimming, 950LM, 80CRI, 3000K (CZEN13-0-10V)
- ☐ CZEN13-H: Citizen® 1 x 13W Watt LED Module, Lutron® Hilume A Series Dimming, 950LM, 80CRI, 3000K (CZEN13-H)
- ☐ CZEN18: Citizen® 1 x 18W Watt LED Module, 1000LM, 80CRI, 3000K (CZEN18)
- ☐ CZEN18-0-10V: Citizen® 1 x 18W Watt LED Module, 0-10V Dimming, 1000LM, 80CRI, 3000K (CZEN18-0-10V)
- ☐ CZEN18-H: Citizen® 1 x 18W Watt LED Module, Lutron® Hilume A Series Dimming, 1000LM, 80CRI, 3000K (CZEN18-H)
- ☐ \*\*CZEN26: Citizen® 1 x 26W Watt LED Module, 1800LM, 80CRI, 3000K (CZEN26)
- ☐ \*\*CZEN26-0-10V: Citizen® 1 x 26W Watt LED Module, 0-10V Dimming, 1800LM, 80CRI, 3000K (CZEN26-0-10V)
- ☐ \*\*CZEN26-H: Citizen® 1 x 26W Watt LED Module, Lutron® Hilume A Series Dimming, 1800LM, 80CRI, 3000K (CZEN26-H)
- ☐ XC9030-700: Xicato® 1 x 22W Watt LED Artist Module, 700LM, 95CRI, 3000K (XC9030-700)
- ☐ XC9030-700-0-10V: Xicato® 1 x 22W Watt LED Artist Module, 0-10V Dimming, 700LM, 95CRI, 3000K (XC9030-700-0-10V)
- ☐ XC9030-700-H: Xicato® 1 x 22W Watt LED Artist Module, Lutron® Hilume A Series Dimming, 700LM, 95CRI, 3000K (XC9030-700-H)
- ☐ \*\*XC8030-1300: Xicato® 1 x 22W Watt LED1300LM, 80CRI, 3000K (XC8030-1300)
- ☐ \*\*XC8030-1300-0-10V: Xicato® 1 x 22W Watt LED1300LM, 0-10V Dimming, 80CRI, 3000K (XC8030-1300-0-10V)
- ☐ \*\*XC8030-1300-H: Xicato® 1 x 22W Watt LED1300LM, Lutron® Hilume A Series Dimming, 80CRI, 3000K (XC8030-1300-H)
- ☐ XC8030-1000: Xicato® 1 x 15W Watt LED1000LM, 80CRI, 3000K (XC8030-1300)
- ☐ XC8030-1000-0-10V: Xicato® 1 x 15W Watt LED 0-10V Dimming, 1000LM, 80CRI, 3000K (XC8030-1300-0-10V)
- ☐ XC8030-1000-H: Xicato® 1 x 15W Watt LED Lutron® Hilume A Series Dimming, 1000LM, 80CRI, 3000K (XC8030-1300-H)
- ☐ \*\*XC8030-2000: Xicato® 1 x 36W Watt LED 2000LM, 80CRI, 3000K (XC8030-2000)
- ☐ \*\*XC8030-2000-0-10V: Xicato® 1 x 36W Watt LED, 0-10V Dimming, 2000LM, 80CRI, 3000K (XC8030-2000-0-10V)
- ☐ \*\*XC8030-2000-H: Xicato® 1 x 36W Watt LED Lutron® Hilume A Series Dimming, 2000LM, 80CRI, 3000K (XC8030-2000-H)
- ☐ LEDMR16: 1 x 6 Watt MR16 LED-120V Triac Dimming only. 277 will not dim (LEDMR16)
- ☐ \*LED1525: Edison® 1 x 15 Watt LED 25° 3000K (LED1525)
- ☐ \*LED1525-0-10V: Edison® 1 x 15 Watt LED, 0-10V Dimming, 540LM, 25° 3000K (LED1525-0-10V)
- ☐ \*LED1525-H: Edison® 1 x 15 Watt LED, 0-10V Lutron® Hilume A Series, 540LM, 25° 3000K (LED1525-H)
- ☐ \*LED1540: Edison® 1 x 15 Watt LED, 540LM 3500K (LED1540)
- ☐ \*LED1540-0-10V: Edison® 1 x 15 Watt LED, 0-10V Dimming, 540LM, 40° 3000K (LED1540-0-10V)
- ☐ \*LED1540-H: Edison® 1 x 15 Watt LED, Lutron® Hilume A Series Dimming, 540LM, 25° 3000K (LED1540-H)

\*No Accessory Options Available

\*\*Denotes Active Cooling Mechanism (Synjet Fan) required: Internal to unit.

For Additional LED options not listed, please consult LED MATRIX online, or Factory.

## 3a: LED Driver (Select only if using LED option):

☐

- ☐ INT - Integral (INT)
- ☐ REM - Remote (REM)

\*LED drivers can be integral or remote. An integral driver will power one unit.

## 4. Beam Spread (Reflector Only):

☐

- ☐ F - Flood (F)
- ☐ N - Narrow Flood (NF)
- ☐ S - Spot (S)



Continued on Next Page...



Architectural Lighting Works reserves the right to make changes to fixture design, finish and engineering at any time.

www.archlgtworks.com

# RECESSED LYTESPOT

Page 2 of 3

TYPE:

## 5. Accessory Option:

- ☐ HEX - Hexcell Louvers (HEX)
- ☐ SNOOT - Snoot (SNT)
- ☐ SOLITE - Solite Lens (SOL)
- ☐ LSS - Linear Spread Lens (LSS)
- ☐ \*\*GC - Glare Cap (GC)
- \*\*Not Available in LED Options

## 6. Voltage:

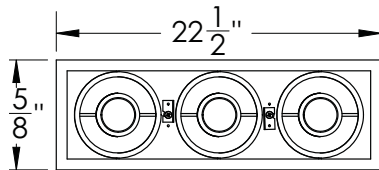
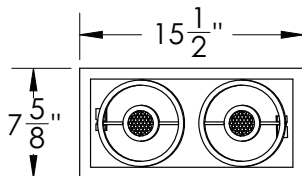
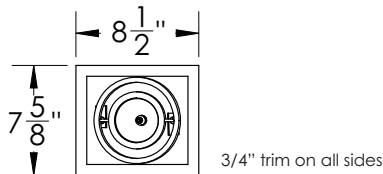
- 
- ☐ 120 - 120 volt (120)
  - ☐ 277 - 277 volt (277)
  - ☐ \*347 - 347 volt (347)
- \*For LED in 347V, consult factory, limitations exist.

## 7. Finish:

- 
- ☐ \* BK/AL (Aluminum trim / Black interior/ Aluminum Gimbal Rings)
  - ☐ AL/AL (Aluminum trim / Aluminum interior/Aluminum Gimbal Rings)
  - ☐ BK/BK (Black trim / Black interior/ Black Gimbal Rings)
  - ☐ BK/BK/AL (Black trim / Black interior/ Aluminum Gimbal Rings)
  - ☐ WH/BK (White trim / Black interior/ Black Gimbal Rings)
  - ☐ WH/WH/ (White trim / White interior/ White Gimbal Rings)
  - ☐ WH/WH/AL (White trim / White interior/ Aluminum Gimbal Rings)
  - ☐ RAL/AL (Specify RAL # of powdercoat of your choice/ Aluminum Gimbal Rings)
  - ☐ RAL/RAL (Specify RAL # of powdercoat of your choice/ RAL Gimbal Rings)

\* BK/AL is standard on all Lytespot housings and trims  
If TRIMLESS is specified, disregard trim color.

RCST (Trim)



Continued on Next Page...

For installation in grid or drywall ceiling.  
Installation instructions at [www.archltgworks.com](http://www.archltgworks.com)

## Design Specifications

### Construction

20 ga CRS housing.  
Black standard in interior housing  
Reflectors are spun and polished aluminum

### Electrical Details

All Ballasts are Electronic <10% THD (where applicable)  
Class P electronic ballasts  
Standard and dimming ballasts are integral to housing (unless otherwise noted - where applicable))  
Low voltage transformers are individual 75W units (277V/12V or 120/12V)  
Additional LED options available (consult factory)  
ETL Listed  
Indoor Location Only

### Emergency

No Emergency Options

### Finish

AL trim is a supersonic chrome powdercoat finish.  
Powder Coat options are available. Consult factory.



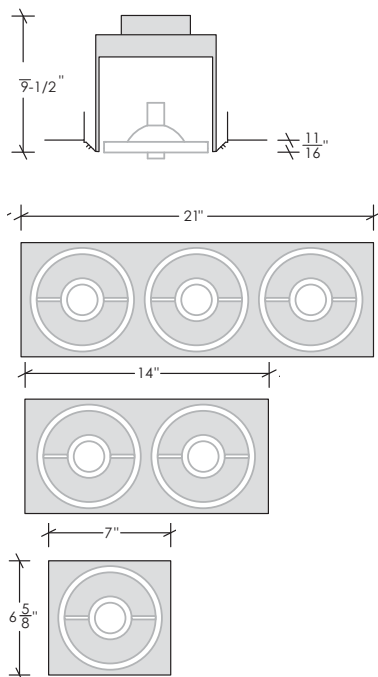
Architectural Lighting Works reserves the right to make changes to fixture design, finish and engineering at any time.

[www.archltgworks.com](http://www.archltgworks.com)

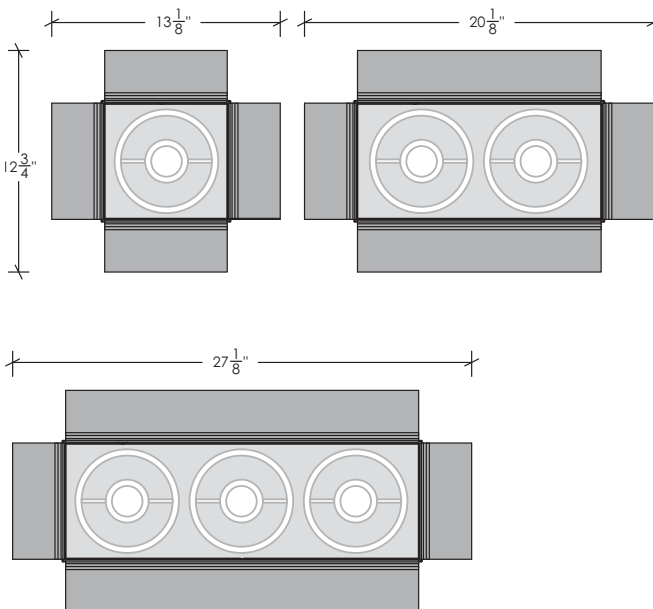
# RECESSED LYTESPOT

Page 3 of 3

RCS (Trim-less)



RCS (Trim-less) - Extruded drywall mudding and structural flange (integral to trim-less unit). Mud to edges for trim-less applications.



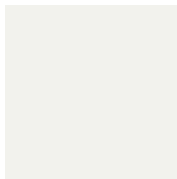
## Colors and Finishes:



STANDARD: "Ulti-matte" Natural aluminum : A two step, clear anodizing process that gives and durable surface.



OPTION: Black - BK powdercoat



OPTION: White - WH powdercoat

# RAL

OPTION: RAL - powdercoat the RAL color of your choice. Specify RAL code.

## Lamp Shielding Accessories:



Hexcel Louver (HEX)



Linear Spread Lens (LSS)



Solite Lens (SOL)



Bladed Louver (BLV)



Snoot (SNOOT)

Note: Accessories are not universal. Please consult specification sheets online for lamp compatibility.



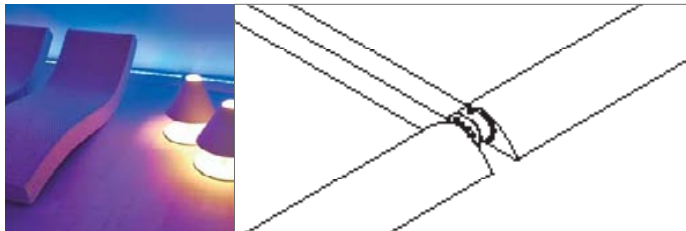
Architectural Lighting Works reserves the right to make changes to fixture design, finish and engineering at any time.

[www.archltgworks.com](http://www.archltgworks.com)



100 Series  
**MLR Sidekick System**  
VodeRail & Bee+ Rail T5

100 Series Specification Guide



**100 Series MLR SideKick System** for T5HE or T5HO fluorescent. Stack or suspension mount. Single-sided or double-sided option. 2'(61cm) – 8'(244cm) lengths, depending on lamp and rail type. Quick-connect wiring harness standard. Patented hub design with 370° rotation, angle-gauge and lock-screw. Brushed aluminum finish standard.



WingRail



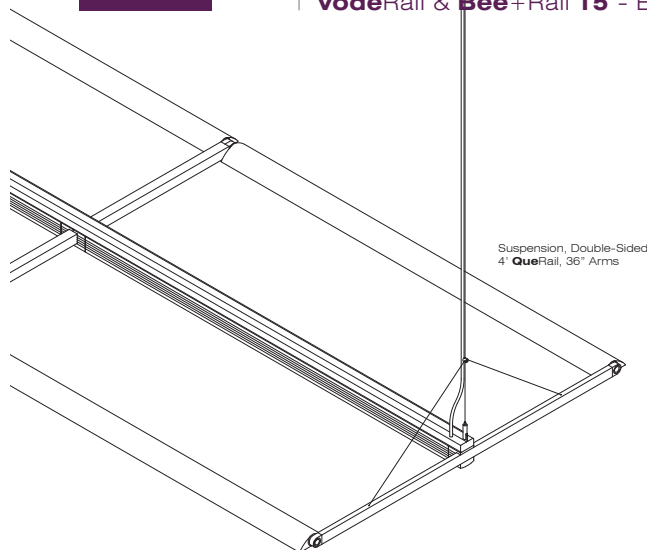
QueRail with slots

[www.vode.com](http://www.vode.com)

1 / 8



100 Series  
**MLR SideKick System**  
**VodeRail & Bee+Rail T5** - Example Configurations



Stack, Double-Sided, 3' **WingRail**  
 3' **QueRail**, 66" Arms

Stack, Single-Sided  
 3' **WingRail**, 24" Arms

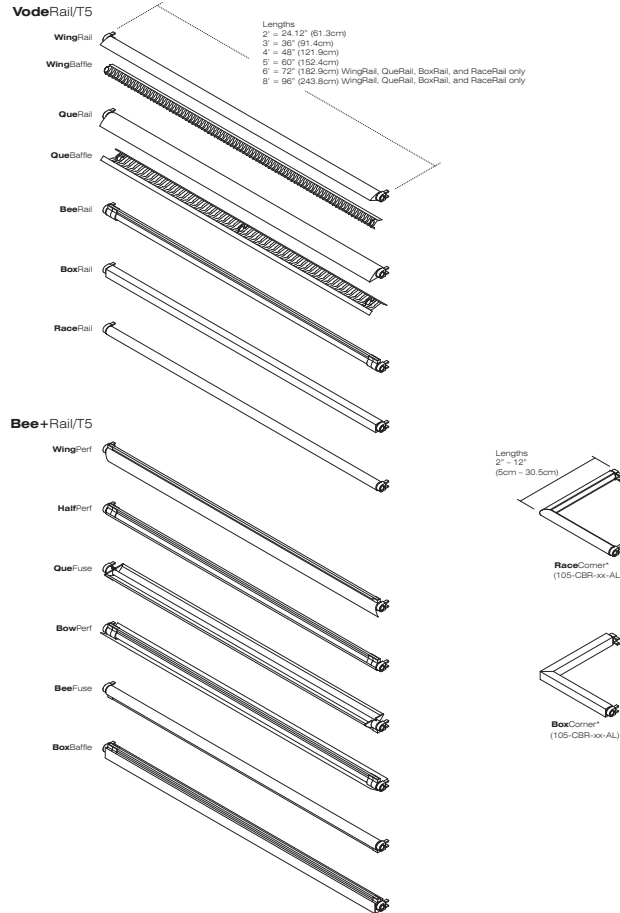
[www.vode.com](http://www.vode.com)

2 / 8



100 Series  
**MLR SideKick System**  
**VodeRail & Bee+Rail T5 - Rail Types**

100 Series | Specification Guide



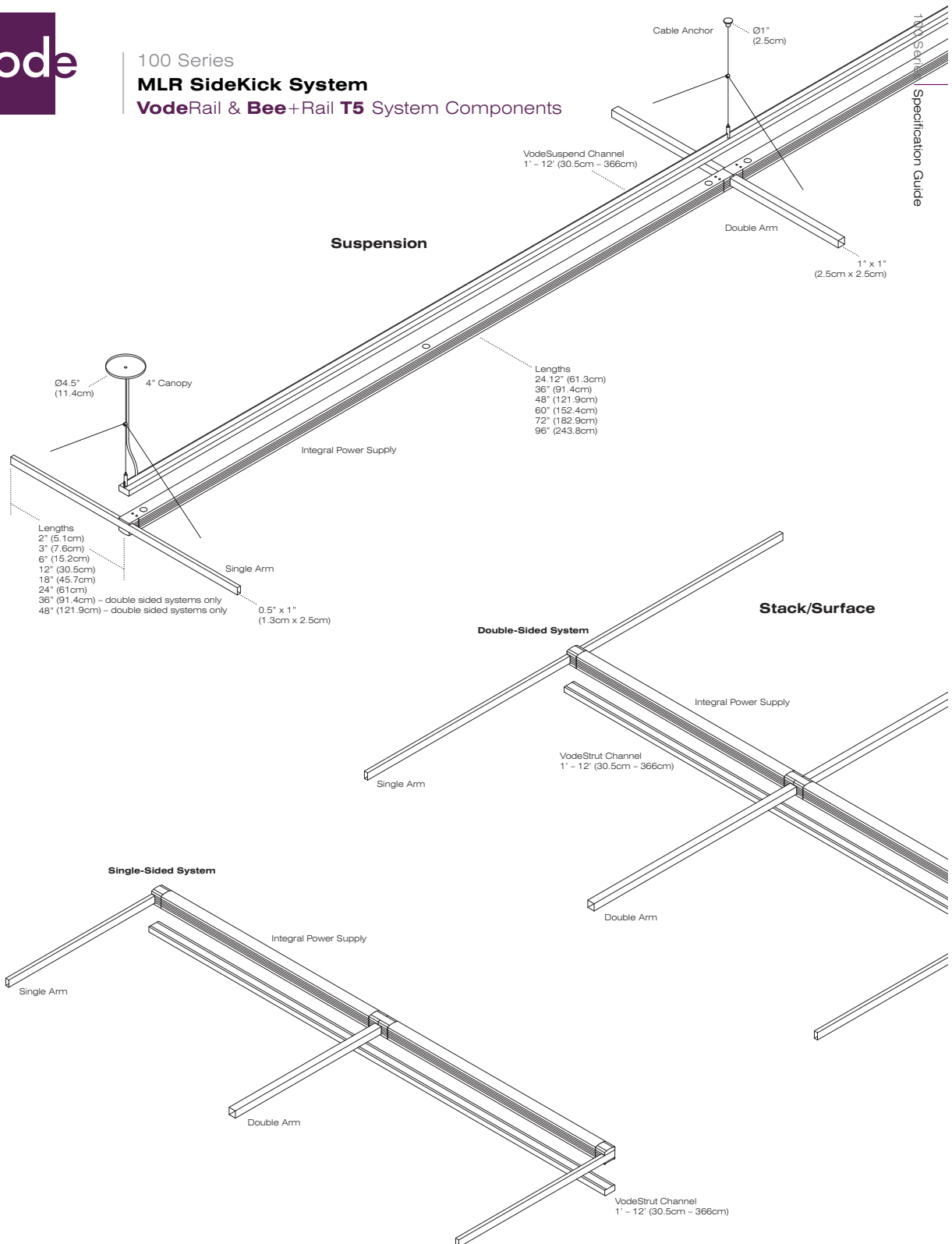
\*Not an illuminated product.  
 \*Must be specified separately from System Specification Code.



100 Series

## MLR SideKick System

VodeRail & Bee+Rail T5 System Components



www.vode.com

4 / 8





100 Series

## MLR SideKick System

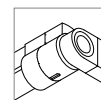
### VodeRail T5 - Specification Sheet

100 Series | Specification Guide

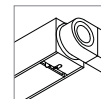
LIGHTING DESIGN ALLIANCE

Specification Code	Rail Type	Single/Double Rail	Layout	Mounting	Arm/Cord Length	Ballast Location	Ballast Type/Voltage	Emergency Ballast	Lamp Type	Finish	Lens/Baffle	Options
	1	2	3	4	5	IB	7	8	9	10	11	12

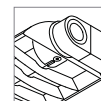
1	<b>Rail Type</b> <b>BE</b> BeeRail <b>RR</b> RaceRail <b>BX</b> BoxRail <b>WG</b> WingRail <b>QU</b> QueRail	
2	<b>Single/Double Rail</b> <b>K1</b> single-sided <b>K2</b> double-sided	
3	<b>Layout</b> See Layout Chart on page 142. Choose length (in feet) and corresponding "A" or "B" layout. "A" and "B" are common layouts. If "A" or "B" layouts are not desired, choose "C" (Custom Layout) and specify desired layout. Please note that <b>Bee</b> Rail is limited to 5' maximum length.	
4	<b>Mounting</b> <b>ST</b> stack/surface <b>SV</b> stack/surface with VodeStrut <b>SS</b> suspension*  *available for double-sided ( <b>K2</b> ) systems only Standard suspension hardware includes VodeSuspend Channel, 6' power cord, cable and 4.5" jbox cover.	
5	<b>Arm/Cord Length</b> <b>2</b> 2" arm <b>18</b> 18" arm <b>60</b> 60" cable/cord <b>3</b> 3" arm <b>24</b> 24" arm <b>XX</b> custom length <b>6</b> 6" arm <b>36</b> 36" arm* <b>12</b> 12" arm <b>48</b> 48" arm* (maximum)  *single-sided ( <b>K1</b> ) arms cannot exceed 24". Arm length is calculated from center of ballast housing.	
6	<b>Ballast Location</b> <b>IB</b> integral ballast	
7	<b>Ballast Type</b> <b>A</b> programmed start <b>B</b> 10% dimming - Lutron Eco-10 <b>C</b> 1% dimming - Lutron Hi-lume <b>D</b> 1% DALI dimming - Osram <b>E</b> 10% DALI dimming - Lutron Ecosystem  Maximum remote distance from 2' to 18' depending on ballast type. See Ballast Chart on page 144.	<b>F</b> 1% dimming (0 - 10v) <b>G</b> bi-level dimming <b>H</b> 1% DALI dimming - Lutron Hi-Lume 3D <b>X</b> other (specify)  <b>Voltage</b> <b>1</b> 120v <b>2</b> 277v <b>3</b> 347v <b>4</b> 220v
8	<b>Emergency Ballast</b> <b>0</b> none <b>X</b> indicate number of emergency ballasts required  Emergency ballast not available with 2' & 3' Rail sections.	
9	<b>Lamp Type</b> <b>HE</b> high efficiency T5 <b>HO</b> high output T5 2' = 14w    5' = 35w      2' = 24w    5' = 80w 3' = 21w    6' = (2) 21w      3' = 39w    6' = (2) 39w 4' = 28w    8' = (2) 28w      4' = 54w    8' = (2) 54w	
10	<b>Finish</b> <b>A</b> brushed aluminum (standard) <b>WH</b> white powdercoat <b>BL</b> black anodized	
11	<b>Lens/Baffle</b> <b>0</b> none <b>1</b> prismatic lens* <b>B</b> cross baffle** <b>S</b> indirect†  Please refer to <b>Bee+</b> Rail specification guide for accessory reflectors for <b>Bee</b> Rail. *option for <b>QU</b> and <b>WG</b> only, standard for <b>RR</b> and <b>BX</b> **option for <b>QU</b> and <b>WG</b> only †option for <b>WG</b> , <b>BX</b> and <b>QU</b> only	
12	<b>Options</b> <b>0</b> none <b>F</b> GLR fuse <b>1</b> on/off toggle switch <b>L</b> lamps provided (specify color temperature) <b>2</b> daylight sensor <b>CP6</b> 6' 14/3 clear power cord and plug <b>3</b> occupancy sensor <b>EP</b> conduit adapter for end power feed	



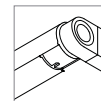
BeeRail



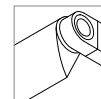
BoxRail



QueRail



RaceRail



WingRail

www.vode.com

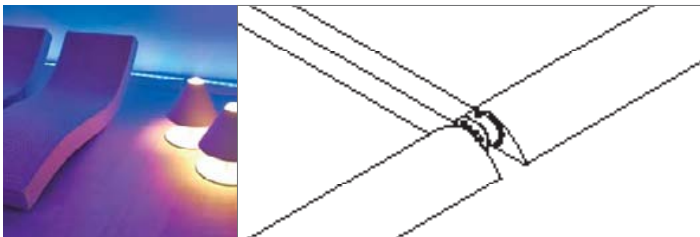
5 / 8



100 Series  
**MLR Sidekick System**  
**VodeRail & Bee+ Rail T5**

100 Series | Specification Guide

LIGHTING DESIGN ALLIANCE



**100 Series MLR Sidekick System** for T5HE or T5HO fluorescent. Stack or suspension mount. Single-sided or double-sided option. 2'(61cm) – 8'(244cm) lengths, depending on lamp and rail type. Quick-connect wiring harness standard. Patented hub design with 370° rotation, angle-gauge and lock-screw. Brushed aluminum finish standard.



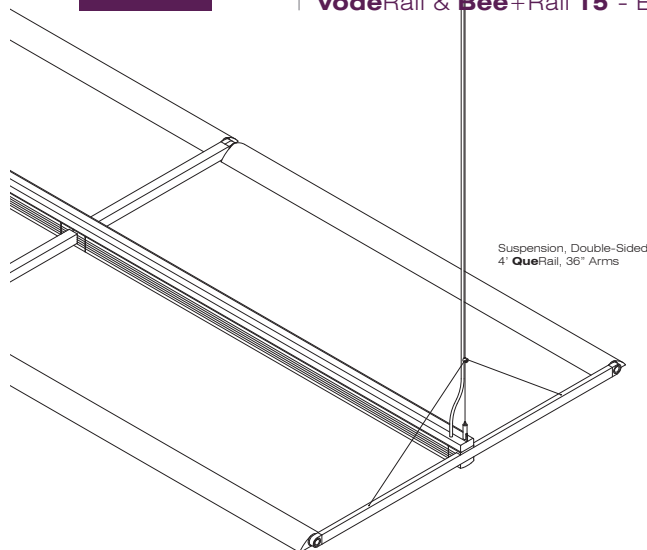
WingRail



QueRail with slots



100 Series  
**MLR SideKick System**  
**VodeRail & Bee+Rail T5** - Example Configurations



Stack, Double-Sided, 3' **WingRail**  
 3' **QueRail**, 66" Arms

Stack, Single-Sided  
 3' **WingRail**, 24" Arms

[www.vode.com](http://www.vode.com)

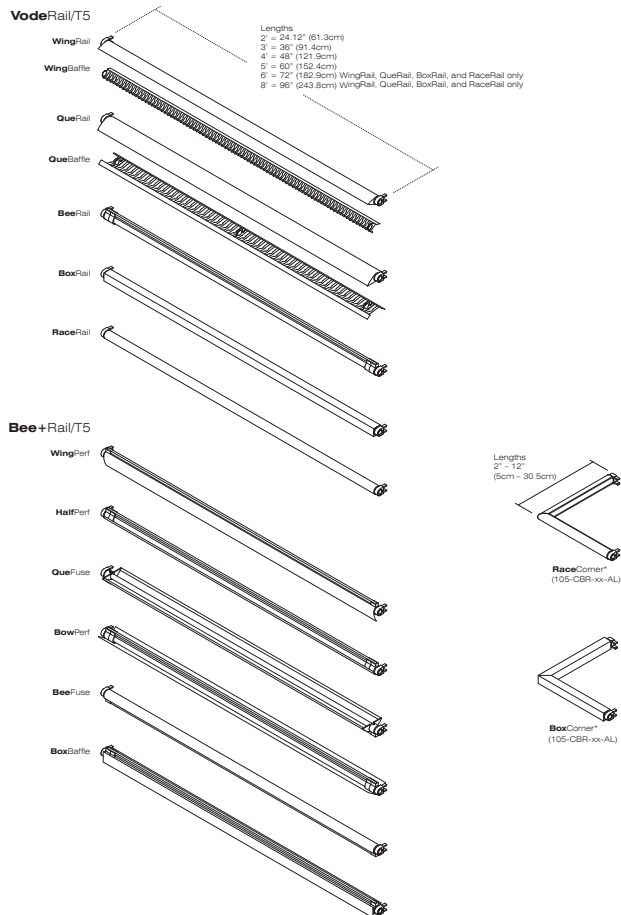
2 / 8



100 Series  
**MLR SideKick System**  
**VodeRail & Bee+Rail T5 - Rail Types**

100 Series | Specification Guide

LIGHTING DESIGN ALLIANCE



\*Not an illuminated product.  
\*Must be specified separately from System Specification Code.

[www.vode.com](http://www.vode.com)

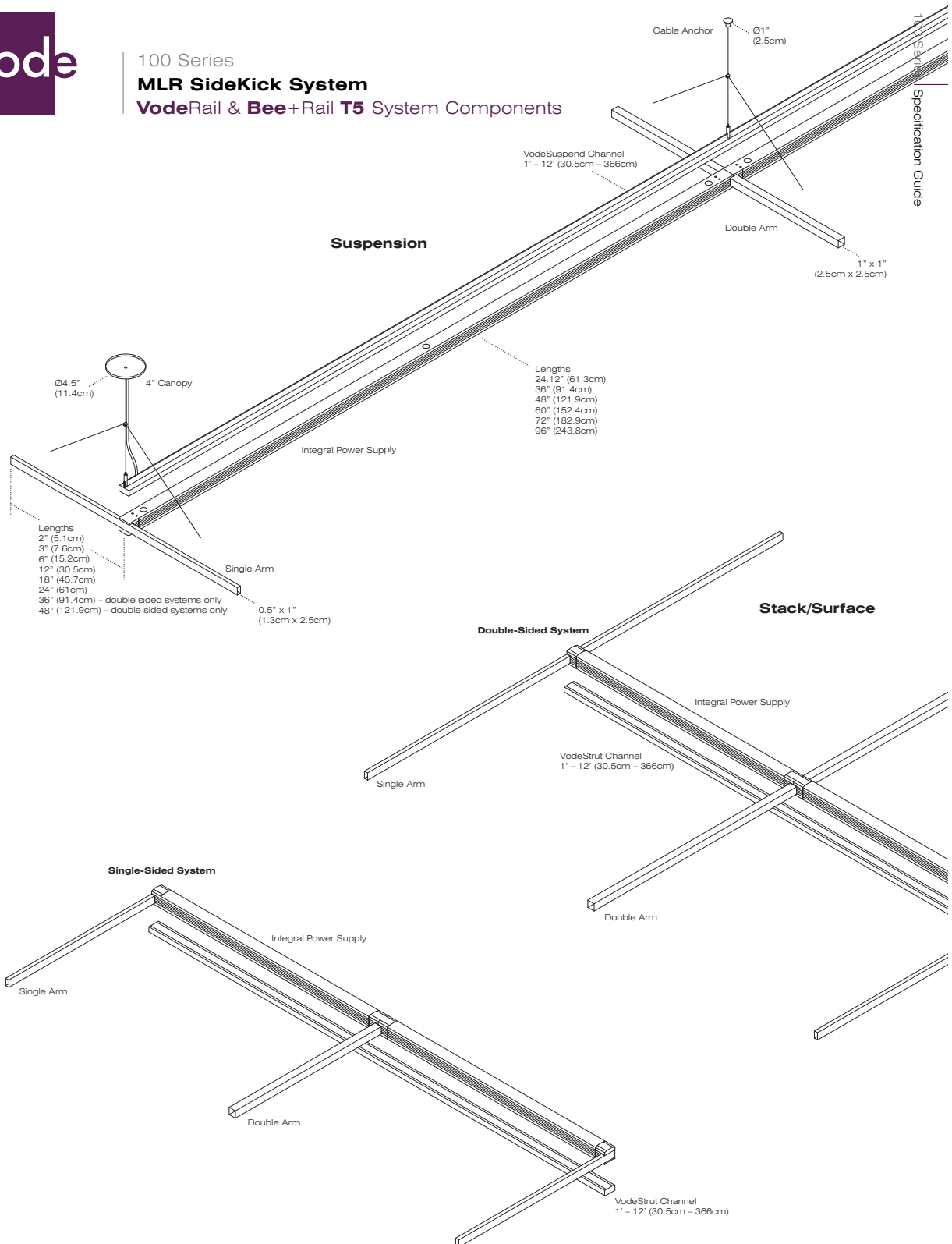
3 / 8



100 Series

## MLR SideKick System

VodeRail & Bee+Rail T5 System Components



www.vode.com

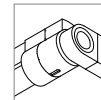
4 / 8



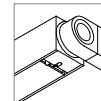
100 Series  
**MLR SideKick System**  
**VodeRail T5 - Specification Sheet**

Specification Code	Rail Type	Single/Double Rail	Layout	Mounting	Arm/Cord Length	Ballast Location	Ballast Type/Voltage	Emergency Ballast	Lamp Type	Finish	Lens/Baffle	Options
	1	2	3	4	5	IB	7	8	9	10	11	12

1	<b>Rail Type</b> <b>BE</b> BeeRail <b>RR</b> RaceRail <b>BX</b> BoxRail <b>WG</b> WingRail <b>QU</b> QueRail	
2	<b>Single/Double Rail</b> <b>K1</b> single-sided <b>K2</b> double-sided	
3	<b>Layout</b> See Layout Chart on page 142. Choose length (in feet) and corresponding "A" or "B" layout. "A" and "B" are common layouts. If "A" or "B" layouts are not desired, choose "C" (Custom Layout) and specify desired layout. Please note that <b>BeeRail</b> is limited to 5' maximum length.	
4	<b>Mounting</b> <b>ST</b> stack/surface <b>SV</b> stack/surface with <b>VodeStrut</b> <b>SS</b> suspension*  *available for double-sided ( <b>K2</b> ) systems only Standard suspension hardware includes <b>VodeSuspend</b> Channel, 6' power cord, cable and 4.5" jbox cover.	
5	<b>Arm/Cord Length</b> <b>2</b> 2" arm <b>18</b> 18" arm <b>60</b> 60" cable/cord <b>3</b> 3" arm <b>24</b> 24" arm <b>XX</b> custom length <b>6</b> 6" arm <b>36</b> 36" arm* <b>12</b> 12" arm <b>48</b> 48" arm* (maximum)  *single-sided ( <b>K1</b> ) arms cannot exceed 24". Arm length is calculated from center of ballast housing.	
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7	<b>Ballast Type</b> <b>A</b> programmed start <b>B</b> 10% dimming - Lutron Eco-10 <b>C</b> 1% dimming - Lutron Hi-lume <b>D</b> 1% DALI dimming - Osram <b>E</b> 10% DALI dimming - Lutron Ecosystem  Maximum remote distance from 2' to 18' depending on ballast type. See Ballast Chart on page 144.	<b>F</b> 1% dimming (0 - 10v) <b>G</b> bi-level dimming <b>H</b> 1% DALI dimming - Lutron Hi-Lume 3D <b>X</b> other (specify)  <b>Voltage</b> <b>1</b> 120v <b>2</b> 277v <b>3</b> 347v <b>4</b> 220v
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9	<b>Lamp Type</b> <b>HE</b> high efficiency T5 <b>HO</b> high output T5 2' = 14w    5' = 35w      2' = 24w    5' = 80w 3' = 21w    6' = (2) 21w      3' = 39w    6' = (2) 39w 4' = 28w    8' = (2) 28w      4' = 54w    8' = (2) 54w	
10	<b>Finish</b> <b>A</b> brushed aluminum (standard) <b>WH</b> white powdercoat <b>BL</b> black anodized	
11	<b>Lens/Baffle</b> <b>0</b> none <b>1</b> prismatic lens* <b>B</b> cross baffle** <b>S</b> indirect†  Please refer to <b>Bee+Rail</b> specification guide for accessory reflectors for <b>BeeRail</b> . *option for <b>QU</b> and <b>WG</b> only, standard for <b>RR</b> and <b>BX</b> **option for <b>QU</b> and <b>WG</b> only †option for <b>WG</b> , <b>BX</b> and <b>QU</b> only	
12	<b>Options</b> <b>0</b> none <b>F</b> GLR fuse <b>1</b> on/off toggle switch <b>L</b> lamps provided (specify color temperature) <b>2</b> daylight sensor <b>CP6</b> 6' 14/3 clear power cord and plug <b>3</b> occupancy sensor <b>EP</b> conduit adapter for end power feed	



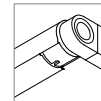
BeeRail



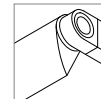
BoxRail



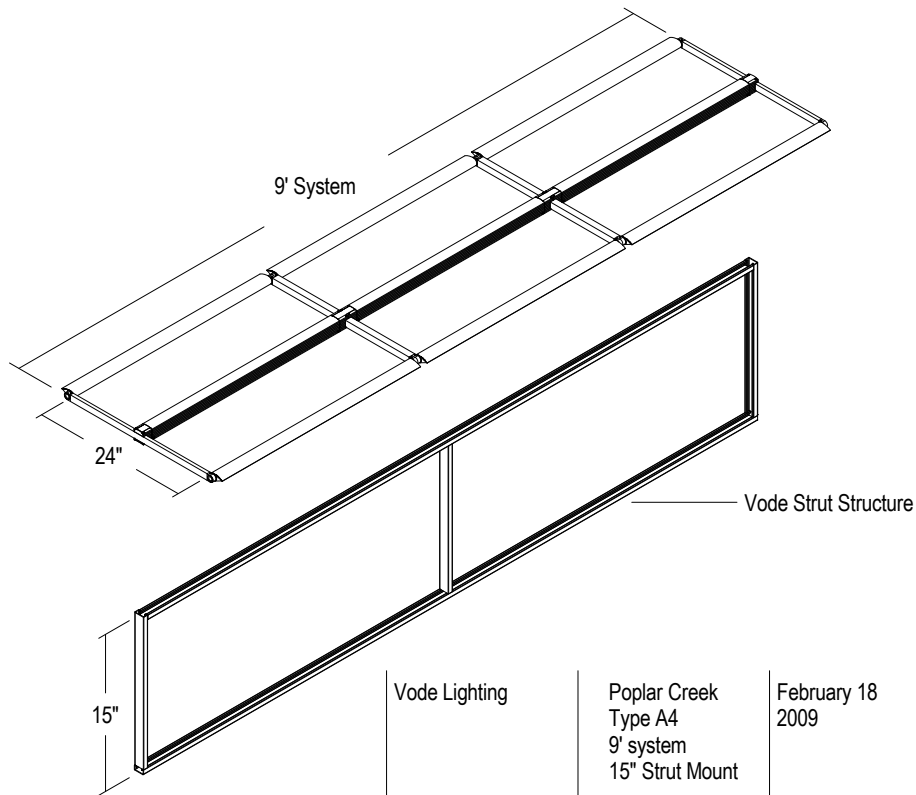
QueRail



RaceRail



WingRail



Product code:  
WG-24-9A-K2-00-IB-A-0-ST-A-0-0  
Vode stack-mounted SideKick system - two-sided, 9' long, comprised of (3) 3' Rail on each side, 24\"/>

Vode Lighting LLC 1206 East MacArthur Street Suite 3 Sonoma, CA 95476 T 707 996 9898 F 707 996 9797 [www.vode.com](http://www.vode.com)

Copyright 2008 All ideas, arrangements, and plans indicated or represented by the above drawings, are the property of Vode Lighting LLC. and were created, evolved, and developed for use on and in connection with the specified project. No part of the above drawing, design, arrangements or ideas thereon shall be duplicated or used for any purpose whatsoever without the express permission of Vode Lighting, LLC.

## Radio Powr Savr™ Wireless Daylight Sensor

Lutron's wireless daylight sensor is a battery-powered sensor that automatically controls lights via RF communication to compatible dimming or switching devices. This sensor mounts to the ceiling and measures light in the space. The sensor then wirelessly transmits the light level to the associated dimming or switching devices that automatically control the lights to balance light level in the space. The sensor combines both convenience and exceptional energy savings along with ease of installation.

### Features

- Utilizes ClearConnect™ technology.
- Daylight compensation through Lutron's reliable open loop control.
- Light range 0–107,000 Lux (0–10,000 fc).
- Designed to give a linear response to changes in viewed light level.
- Wireless daylight sensor has simple calibration.
- One sensor can be associated to up to 10 compatible RF dimming and switching devices allowing for switching, stepped dimming, and continuous dimming of multiple zones.
- Intuitive test mode provides instant system verification.
- 10-year battery life.
- Multiple ceiling mount methods available for different ceiling materials.
- Works seamlessly with Radio Powr Savr™ occupancy sensors and Pico® wireless controls.
- Front accessible test buttons make setup easy.
- RoHS compliant.



### Model Number:

LRFX-DCRB-XX

Color Code

Frequency / Channel Code

### Frequency / Channel Codes:

2 = 433.0 - 437.0 MHz (US, Canada, Mexico)

3 = 868.125 - 869.850 MHz (Europe)

4 = 868.125 - 868.475 MHz (China)

5 = 865.5 - 866.5 MHz (India)

7 = 433.0 - 437.79 MHz (Hong Kong)

### Color Codes:

WH = White

Contact Lutron Customer Service at [www.lutron.com](http://www.lutron.com) for frequency/channel code compatibility with your particular geographic region, and for integrating with other Lutron® lighting and shading products.

### Compatible RF Devices:

- For use with Lutron® products only
- Communicates to the following wireless Lutron® systems:
  - GRAFIK Eye® QS Wireless
  - Rania® Wireless RF Switch (LRF 3, 4, 5 & 7 Only)
  - Energi Savr Node™ QS (with QSM on QS Link)
  - Maestro Wireless® (LRF 2 Only)
  - Quantum® Systems

## LUTRON® SPECIFICATION SUBMITTAL

Page

Job Name:

Model Numbers:

Job Number:



## Specifications

### Regulatory

Lutron® Quality Systems Registered to ISO 9001:2008.

#### LRF2-

- FCC Approved. Complies with the limits for a Class B digital device. Pursuant to Part 15 of the FCC Rules.
- IC (RSS-210).
- SCT.
- Meets CAA Title 24 requirements.

#### LRF3-

- CE - Marked (European Union).
- TRA Type Approved (United Arab Emirates).

#### LRF4-

- SRRC Type Approved (Mainland China).
- iDA Registered (Singapore).

#### LRF5-

- WPC Type Approved (India).

#### LRF7-

- FCC Approved. Complies with the limits for a Class B digital device. Pursuant to Part 15 of the FCC Rules.
- Approved under OFTA short range device class license.

### Power/Performance

- Operating voltage: 3 V==
- Operating current: 7  $\mu$ A
- Requires one CR 2450 lithium battery.
- 10-year battery life.
- Non-volatile memory.  
(settings are stored during power loss)

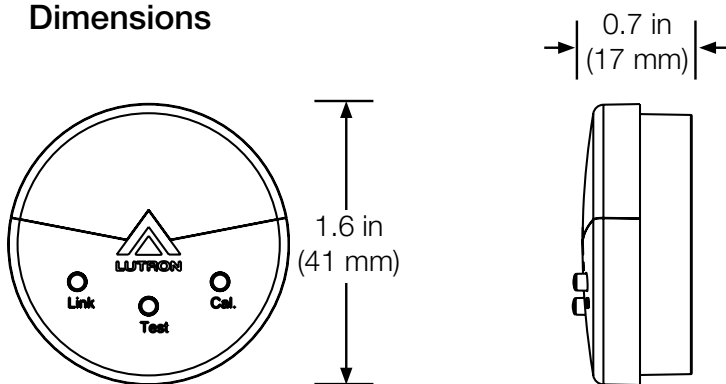
### Enviroment

- Temperature: 32 °F to 104 °F (0 °C to 40 °C).
- For indoor use only.
- Relative humidity: < 90% non-condensing

### Range

- Local load controls must be located within 60 ft (18 m) line of sight, or 30 ft (9 m) through walls, of a daylight sensor.

## Dimensions



**LUTRON®** SPECIFICATION SUBMITTAL

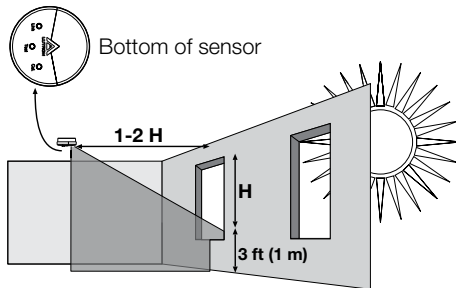
Page

Job Name:	Model Numbers:
Job Number:	

## Mounting

### Location for average size areas

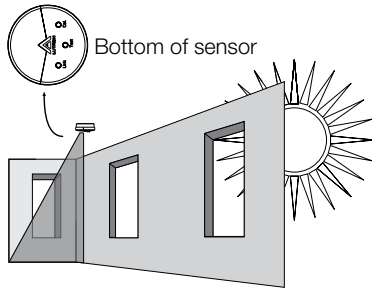
Arrow points towards the area viewed by the sensor (towards windows).



H = Effective Window Height

### Location for narrow areas (corridors, private offices)

Arrow points towards the area viewed by the sensor (away from window)



## Installation

### Determine the Daylight Sensor mounting location using the diagrams at left:

- The arrow on the daylight sensor points toward the area viewed by the sensor.
- Place the daylight sensor so its arrow is pointed at the nearest window at a distance from the window of one to two times the effective window height (H).
- The effective window height (H) starts at the window sill or 3 ft (1 m) up from the floor, whichever is higher, and ends at the top of the window.
- Ensure that the view of the daylight sensor is not obstructed.
- Do not position the daylight sensor above an electric light that shines up at the ceiling or at the sensor.
- Do not position the daylight sensor in the well of a skylight or above indirect lighting fixtures.
- For narrow areas where the daylight sensor cannot be placed 1-2 (H) from windows, place sensor near windows facing into the space.
- Mount Sensor(s) away from large metal surfaces (e.g. light fixtures or metal-backed ceiling tiles). Metal objects will affect the Sensor's RF performance.

## Daylight Sensor Communication

- A sensor can communicate with up to 10 local load devices.
- A single local load device or zone can have only one daylight sensor communicate to it.

## LUTRON® SPECIFICATION SUBMITTAL

Page

Job Name:

Model Numbers:

Job Number:

# Model comparison

## GRAFIK Eye® QS



Now with Clear Connect RF Technology™, GRAFIK Eye QS enables reliable communication with Lutron® light and shade control products in a space.

- Eliminates the need to run communication wiring to shades, sensors and additional GRAFIK Eye QS units
- Available in 3-, 4-, and 6-zone configurations
- Integral phase control dimmers provide control of incandescent/halogen, magnetic low-voltage, Lutron Tu-Wire® fluorescent dimming ballasts, and non-dimmed lighting loads
- Wired-only options available

## GRAFIK Eye QS with EcoSystem®



The GRAFIK Eye QS with EcoSystem combines the flexibility and scalability of the standard model with the additional benefit of an integral EcoSystem bus supply.

- Direct connection to Lutron digital fluorescent ballasts and LED drivers
- Available in 6-, 8-, and 16-zone configurations
- Wired-only options available





1B  
1-button



2B  
2-button



3B  
3-button



5B  
5-button



7B  
7-button



2BRL  
2-button with  
raise/lower



3BRL  
3-button with  
raise/lower



5BRL  
5-button with  
raise/lower



2BRLIR  
2-button with  
IR receiver and  
raise/lower



3BRLIR  
3-button with  
IR receiver and  
raise/lower



5BRLIR  
5-button with  
IR receiver and  
raise/lower



1RLD  
Dual with 3-button  
and 2-button with  
raise/lower



2RLD  
Dual 2-button  
with raise/lower



3BD  
Dual 3-button

Lutron | 17

SECTION 27 00 00 -- COMMUNICATIONS

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. The communications contractor is aware that the space beneath the access floor will be used as an air delivery plenum and as such will take the necessary precautions when installing their work so as not to impact the integrity of the plenum space specific to air leakage and cleanliness. Any penetrations or holes in the under floor plenum created for or resulting from the work performed by the division 26 communications contractors are required to be properly sealed to prevent air leakage.

1.2 SUMMARY

A. Section Includes

- 1. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Voice and Data Communications infrastructure indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems. General design intent for this project is shown on the drawings and described in the specifications.
- 2. All equipment requiring coordination with other trades must be tested and verified for proper operation. Contractor is fully responsible for the coordination and must resolve all conflicts with equipment that connect or interact with other systems.
- 3. Design, engineer and provide complete means of support, suspension, attachment, fastening, bracing, and seismic restraints (hereinafter "support") of the Work of this Section, including future installed equipment, in accordance with local building codes and regulations. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Contractor shall obtain the services of an engineer licensed to perform this work within the state or jurisdiction it is to be performed.
- 4. The Contractor shall pay for all costs associated with structural engineering required by code for work in this section.
- 5. Conduit and common back boxes are by Division 26 Contractor.
- 6. Provide all cable and wire associated with this specification section.
- 7. All systems shall be completely installed with all of the necessary interconnection, power supplies, patch cords and wiring to provide a fully functioning system.

B. Related Sections

- 1. Section 27 05 26 – Grounding and Bonding for Communications Systems
- 2. Section 27 11 16 – Communications Cabinets, Racks, and Enclosures

1.3 REFERENCES

A. Comply with the following applicable organizations and standards:

- 1. This Technical Specification and Associated Drawings
- 2. City of Santa Monica Structured Cabling System and IDF Build out Standards
- 3. Building Industries Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM) – 12th edition

4. ANSI/TIA/EIA-568-C-0 –Generic Telecommunications Cabling for Customer Premises
5. ANSI/TIA/EIA-568-C-1 - Commercial Building Telecommunications Cabling Standard
6. ANSI/TIA/EIA-568-C-2 - Commercial Building Telecommunications Cabling Standard - Balanced Twisted-Pair Cabling Components
7. ANSI/TIA/EIA-568-C-3 - Optical Fiber Cabling Components Standard
8. ANSI/TIA/EIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces
9. ANSI/TIA/EIA-598-B - Fiber Optic Cable Color Coding
10. ANSI/TIA/EIA-606-A - Administration for Telecommunications Infrastructure for Commercial Buildings
11. ANSI/J-STD-607-A - Commercial Building Grounding and Bonding Requirements for Tele-communications
12. ANSI/TIA/EIA-758 –A- Customer-Owned Outside Plant Telecommunications Cabling Standard
13. TIA-942 - Telecommunications Infrastructures for Data Centers
14. Bulletins issued by ANSI/TIA/EIA in conjunction with the above referenced standards.
15. National Fire Protection Agency (NFPA) – NFPA 70, National Electrical Code (NEC) – 2008
16. Comply with all applicable governing codes.

If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents; the vendor is responsible to determine and adhere to the most recent release when developing the proposal for installation.

#### 1.4 SYSTEM DESCRIPTION

##### A. Design Requirements

##### 1. General

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required.. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star.

The Santa Monica Pico Branch Library Structured Cabling System includes the following major systems:

- a. Overhead cable tray (inside Communications Rooms), conduits, and J-hook systems to provide pathways for the new building voice, data and video networks.
- b. Raised floor (depressed slab) for cable and power distribution beneath the server room and general areas.
- c. Horizontal cable plant distribution system for voice, data and video communications.
- d. Wall-to wall distribution for wireless data communications systems.
- e. Building telecommunications equipment room layouts.
- f. Equipment racks, patch panels and cross-connect designs and layouts.

- g. Electrical and HVAC provision for the technology systems including the voice, data, video networks and audio-visual systems.

B. TEF (Entrance Facility / Telecommunications Room)

1. This room will serve as the main equipment room for:
  - a. Building service entrance for outside facilities for the voice, data, video networks and auxiliary systems interconnected to the service providers.
  - b. The building demarcation point and main wiring distribution point.
  - c. The TEF will house rack and wall-mounted equipment:
    - (1) Two 19"x84" self-standing relay racks.
    - (2) One 24 port SC Fiber Optic termination panels and SC connectors.
    - (3) Two 48-port, Category 6, RJ45, 4-pair UTP termination panels.
    - (4) Eight 2ru x19" horizontal wire managers and Two 1ru x 19" horizontal wire managers.
    - (5) One Building Entrance Terminal Protector
    - (6) One 100 pair, 110-style punch block assembly.
    - (7) 12" wide, 9" spaced, open-rung type overhead telecom runway as shown on drawing, at 84" AFF.
    - (8) One 4"x12"x1/4" copper ground bus-bar (TMGB), terminated to the main electrical ground buss via minimum #4 AWG insulated, copper cabling.
    - (9) One Uninterruptable Power Supply (UPS) Size TBD.

C. TR (Telecommunications Room)

This room will serve as the main equipment room for voice and data cable utilized in the Community Center, as well as the main Audio-Video equipment room.

1. The TR will house rack-mounted equipment in the cabinet provided by the AV contractor as follows:
  - a. One 12-port fiber optic cable termination panels with SC connectors and connector panels.
  - b. One 48-ports, Category 6, RJ45, 4-pair UTP termination panels.
  - c. Two 2ru x19" horizontal wire managers and one (1) 1ru x 19" horizontal wire managers.
  - d. One 2"x12"x1/4" copper ground bus-bar (TGB), terminated to the TMGB in the TEF via minimum #4 insulated, copper cabling.

D. Horizontal Cable – Work Stations

1. The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA Category 6 Copper Cables. The cables shall be installed from the Work Area Outlet (WAO) in the work area to the Telecommunications Room (TR) or Telecommunications Equipment Room (TER) serving that area and terminated as specified in this document.
2. Each work station outlet shall have at least 2 Category 6 cables unless noted otherwise. Refer to T drawings for actual count at each station.
3. Station cables shall be installed in conduit, in cable tray and in modular furniture. Outlets shall be mounted flush on a wall-mounted box, on Surface Raceway and in Modular Furniture. Information Outlet locations are to be identified on Project Drawings
4. Backbone Copper and Fiber Optic Cables (linking Equipment Rooms and/or Telecommunications Rooms) shall be installed in conduit in building riser pathways, in cable tray and/or free-air in as identified on the Drawings.



## 1.5 SUBMITTALS

### A. General

1. In addition to the requirements of Division 1, submit all materials for review arranged in the same order as the Specification, individually referenced to the Specification paragraph and Contract Drawing number. Submit 8 1/2" x 11" items bound in volumes and drawings in edge-bound sets. Submit all drawings on sheets of the same size.
2. The Contractor is to provide three copies of each hardcopy submittal at minimum.
3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
4. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception Taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
5. In the event that the Contractor deviates from the design shown on the audio-visual Contract Documents when preparing their shop drawings, the Contractor shall indicate with architectural style clouding, those deviations. The Contractor shall also submit with the Shop Drawings, a list of those deviations and substitutions, including the following:
  - a. The deviation item number which shall also correspond to a number designation applied to each cloud on the shop drawings.
  - b. Section of the specification that applies to these changes.
  - c. The applicable shop drawing sheet number for each item.
  - d. The corresponding audio-visual Contract Document sheet number for each item.
  - e. A clear description of the deviation.
  - f. The Contractor's rational for the deviation (i.e. what benefit the deviation provides, why it is required, any cost impact, etc.).

### B. Close Out Submittal

1. Operation and Maintenance Manuals
  - a. Index.
  - b. Systems operating instructions.
  - c. Reduced set of system Record Drawings.
  - d. Maintenance and spare parts schedules.
  - e. Shop and Field Test Reports.
  - f. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals in color for each equipment item. Provide tabbed dividers between each product. Manuals provided by the Manufacturer in an individual binder may be submitted in that form.
2. Framed Operating and Maintenance Instructions: Provide adjacent to each ensemble of equipment racks. Provide sturdy frame with clear glass or non-scratching plastic cover. Provide permanent, non-fading media. Blueprints shall not be acceptable. Include:
  - a. Sequence for system start-up and shutdown.
  - b. System Functional Diagrams.
3. Provide four copies on CD-ROM containing the "as built" drawings, all manuals, test results of all links, Category 6 copper cables, and all fiber strands.

4. Warranty Certificates

- a. Comply with Division 1.

1.6 QUALITY ASSURANCE

A. Qualifications

1. The bidder shall, prior to the bid, in accordance with the Instruction to Bidders, submit at least the following information to verify that the bidder has the necessary experience and qualifications to perform the specified work:
  - a. A detailed brochure describing the bidder's capabilities in terms of facilities, personnel (include a personnel organization chart followed by resumes), experience, background, examples of similar installations (at least two projects within the past two years), distribution arrangements with manufacturers and financial capability, including certificates of insurance and satisfaction of the project bonding requirements.
  - b. Information identifying any and all local agents and/or subcontractors that will assist in the work and their role in the project.
  - c. Identification of sources of labor for all fabrication and installation throughout the duration of the project.
  - d. Evidence that he has acquired all necessary licenses, certificates and approvals to perform the specified work within the state or jurisdiction the work is to be performed.

1.7 PROJECT SITE CONDITIONS

A. Environment Requirements

1. The spaces where network equipment is installed shall meet the following requirements:
  - a. Free from dust generated from construction.
  - b. The room temperature shall be within the specified operating temperature recommended by the manufacturer.

1.8 SCHEDULING

- A. Comply with the Project schedule.
- B. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section.
- C. Deliver all equipment, devices and materials required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen days prior to the completion date for the associated area of the Project, unless specifically instructed otherwise by the Owner.
- D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner, in lieu of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven days prior to the completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.
- E. It shall be a common understanding that there is a time constraint when executing this work. The Contractor shall use all means and resources to complete this project on or before the specified schedule at no additional cost to the Owner. This includes working beyond normal business hours and days, additional manpower, additional tools, etc.

## 1.9 WARRANTY SERVICE

- A. Warrant all Work of this Section to be free from defects in materials and workmanship for a minimum of 1 year from the date of Owner acceptance of the Work of this Section.
- B. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty may be voided. In such cases, provide a warranty equivalent to that of the original manufacturer.
- C. Response Time: Provide a qualified technician familiar with the work at the Project Site within 12 hours after receipt of a notice of malfunction. Provide the Owner with the telephone number attended 8 hours a day, 5 days a week, and an answering service or equivalent facility attended 24 hours a day, 7 days a week, to be called in the event of a malfunction. Provide repairs at no expense to the Owner and at the Owner's request, alternate facilities, services and systems for the duration of the repairs to any defective work of this Section. Provide a complete and operational System, within 48 hours after notification of a malfunction.
- D. All work requested due to warranty issues shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.
- E. The Contractor shall use qualified service personnel to respond to all warranty issues or calls.

## 1.10 SYSTEM STARTUP

- A. TBD

## 1.11 OWNER'S INSTRUCTIONS

- A. General
  - 1. Conduct training on the completed system at a reasonable convenience of the Owner during normal Owner business hours. Contractor is to assess the complexity of the system and will be held responsible to fully train the operation and maintenance staff named by the Owner.
  - 2. Do not start training until all systems have been commissioned, training manuals are approved and an agenda along with schedule of each departmental training session has been submitted.

## PART 2 - PRODUCTS

### 2.1 Components

- A. UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

### 2.2 Telecommunications Pathway

- A. Provide telecommunications pathways in accordance with TIA/EIA-569-A. Provide system furniture pathways in accordance with UL 1286.

## 2.3 TELECOMMUNICATIONS CABLING

- A. Cabling shall be UL listed for the application and shall comply with TIA-568-C.1, TIA/EIA-568-B.2 with Addendums 1 through 11, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by TIA/EIA-606-A and UL 969. Ship cable in boxes bearing manufacture date for UTP in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

## 2.4 BACKBONE CABLING

### A. Backbone Copper

1. ICEA S-90-661, TIA-568-C.1, TIA/EIA-568-B.2, and UL 444, copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 50-pair Category 5E UTP (Unshielded twisted pair), formed into 25 pair binder groups covered with a thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating Category 5E at regular intervals not to exceed 2 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70. Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70. Color coding shall comply with industry standards for 25 pair cables.

### B. Backbone Optical Fiber

1. Provide in accordance with ICEA S-83-596, TIA-568-C.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches. Hybrid fiber optic cable marking shall comply with TIA/EIA-598-B.
2. Multimode,(OM3) 50/125-um diameter, 0.200 numerical aperture and single-mode,(OS1) 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cable. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber plenum cable (OFNP), and nonconductive optical fiber riser cable (OFNR) rated cable in accordance with NFPA 70 and UL 910. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598-B.

### C. Horizontal Cabling

1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.

### D. Horizontal Copper

1. Provide horizontal copper cable in accordance with TIA/EIA-568-B.2, UL 444, UTP (unshielded twisted pair), 100 ohm. Provide four each individually twisted pair, 24 AWG conductors, Category 6, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 2 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70. Type CMP and CMR may be substituted for type CM

or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70.

E. Horizontal Optical Fiber

1. Provide optical fiber horizontal cable in accordance with TIA-492AAAC, multimode, 50/125-um diameter, 0.200 numerical aperture, tight buffered fiber optic cables. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 40 inches. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber riser cable (OFNR) or nonconductive optical fiber plenum cable (OFNP) in accordance with NFPA 70. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598-B.

2.5 TELECOMMUNICATIONS SPACES

- A. Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment room to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunication interconnecting hardware color coding in accordance with TIA/EIA-606-A.

B. Backboards

1. Provide void-free, interior grade plywood 3/4 inch thick as indicated. Backboards shall be fire rated. Backboards shall be provided on a minimum of two walls in the telecommunication spaces. Do not cover the fire stamp on the backboard.

C. Equipment Support Frame

1. Provide in accordance with CEA-310-E and UL 50.
  - a. Rack, floor mounted modular type, 16 gauge aluminum construction, minimum, treated to resist corrosion. Provide rack with vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and a surge protected power strip with 6 duplex 20 amp receptacles. Rack shall be compatible with 19 inch panel mounting, and shall be Zone Four seismic rated.

D. Connector Blocks

1. Provide insulation displacement connector (IDC) Type 110 for Category 6 and higher systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 50 percent spare.

E. Cable Guides

1. Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inch equipment racks, cabinets, and telecommunications backboards. Cable guides of ring or bracket type devices for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws.

1. Provide ports for the number of horizontal and backbone cables terminated on the panel plus 25 percent spare. Provide pre-connectorized optical fiber and copper patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with TIA-568-C.3. Patch cords shall meet minimum performance requirements specified in TIA-568-C.1 and TIA-568-C.3 for cables, cable length and hardware specified.

F. Fiber Optic Patch Panel

1. Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of 18 gauge steel or 11 gauge aluminum minimum and shall be rack mounted and compatible with a CEA-310-E 19 inch equipment rack. Each panel shall provide 48 multimode and single-mode adapters as duplex SC with thermoplastic alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

A. Outlet/Connector Copper

1. Outlet/connectors shall comply with FCC Part 68TIA-568-C.1, and TIA/EIA-568-B.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA/EIA-568-C.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired T568B as indicated. UTP outlet/connectors shall comply with TIA/EIA-568-C.2 for 200 mating cycles. UTP outlet/connectors installed in outdoor or marine environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.

B. Optical Fiber Adapters

1. Provide optical fiber adapters suitable for duplex SC in accordance with TIA/EIA-604-3A with zirconium ceramic alignment sleeves, as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21-A for 500 mating cycles.

C. Optical Fiber Connectors

1. Provide in accordance with TIA-455-21-A. Optical fiber connectors shall be duplex SC in accordance with TIA/EIA-604-3A with zirconium ceramic, epoxyless compatible with 50/125 multimode or 8/125 single-mode fiber. The connectors shall provide a maximum attenuation of 0.3 dB @ 850nm with less than a 0.2 dB change after 500 mating cycles.

D. Cover Plates

1. Telecommunications cover plates shall comply with UL 514C, and TIA-568-C.1, TIA/EIA-568-C.2, flush design constructed of high impact thermoplastic material in color to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS. Provide labeling in accordance with the paragraph LABELING in this section.

2.7 GROUNDING AND BONDING PRODUCTS

1. Provide in accordance with UL 467, TIA J-STD-607-A, and NFPA 70. Components shall be identified as required by TIA/EIA-606-A. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

2.8 FIRESTOPPING MATERIAL

- A. Provide as specified in Section 07 84 00, FIRESTOPPING.

2.9 MANUFACTURER'S NAMEPLATE

- A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.10 FIELD FABRICATED NAMEPLATES

- A. ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.11 TESTS, INSPECTIONS, AND VERIFICATIONS

- A. Factory Reel Tests

1. Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-526-7 for single mode optical fiber and TIA-526-14-A for multimode optical fiber cables.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with TIA-568-C.1, TIA/EIA-568-B.2, TIA-568-C.3, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.

### 3.2 CABLING

- A. Install Category 6 UTP, and optical fiber telecommunications cabling system as detailed in TIA-568-C.1, and TIA-568-C.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 ft. in the telecommunications room, and 12 inches in the work area outlet. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain un-terminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

#### 1. Open Cable

- a. Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568-C.1, TIA/EIA-568-B.2 and TIA-568-C.3. Do not exceed cable pull tensions recommended by the manufacturer. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.

- (1) Plenum cable shall be used where open cables are routed through plenum areas. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Cable 6 feet long shall be neatly coiled not less than 12 inches in diameter below each feed point in raised floor areas.

#### B. Backbone Cable

1. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.
2. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

#### C. HORIZONTAL CABLING

1. Install horizontal cabling as indicated on drawings between the floor distributors and the telecommunications outlet assemblies at workstations.

### 3.3 WORK AREA OUTLETS

#### A. Terminations



1. Terminate UTP cable in accordance with TIA-568-C.1, TIA/EIA-568-B.2 and wiring configuration as specified.

B. Cover Plates

1. As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

C. Cables

1. Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

D. Pull Cords

1. Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

3.4 TELECOMMUNICATIONS SPACE TERMINATION

- A. Install termination hardware required for Category 5e, Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

B. Connector Blocks

1. Connector blocks shall be rack mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA/EIA-569-A.

C. Patch Panels

1. Patch panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 25 percent spares.
  - a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel with velcro as recommended by the manufacturer to prevent movement of the cable.
  - b. Fiber Optic Patch Panel. Fiber optic cable loop shall be 3 feet in length as recommended by the manufacturer. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

D. Equipment Support Frames

1. Install in accordance with TIA/EIA-569-A:
  - a. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations.
  - b. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets.

3.5 ELECTRICAL PENETRATIONS

1. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00, FIRESTOPPING.

3.6 GROUNDING AND BONDING

1. Provide in accordance with TIA J-STD-607-A, NFPA 70 and as specified in Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

3.7 LABELING

A. Labels

1. Provide labeling in accordance with TIA/EIA-606-A. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using laser printer.

B. Cable

1. Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606-A.

3.8 TERMINATION HARDWARE

- A. Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA/EIA-606-A.

3.9 FIELD APPLIED PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.10 FIELD FABRICATED NAMEPLATE MOUNTING

- A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.11 TESTING

A. Telecommunications Cabling Testing

1. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1 and TIA-568-C.3. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

B. Inspection

1. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1 and TIA-568-C.3. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.

C. Verification Tests

1. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connected.
2. For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-14-A using Method A, Optical Power Meter and Light Source for multimode optical fiber. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source]. Perform verification acceptance tests.

D. Performance Tests

1. Perform testing for each outlet as follows:
  - a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA/EIA-568-B.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
  - b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3.

E. Final Verification Tests

1. Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.
  - a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.
  - b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

END OF SECTION

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.2 SCOPE OF WORK

- A. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Closets).
- B. Included in this section are the minimum composition requirements and installation methods for the following:
  - 1. Busbars
  - 2. Bonding accessories

1.3 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufactures listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- C. Material and work specified herein shall comply with the applicable requirements of:
  - 1. This Technical Specification and Associated Drawings
  - 2. Building Industries Consulting Services International (BICSI) *Telecommunications Distribution Methods Manual* (TDMM) – 12th edition
  - 3. ANSI/TIA/EIA-568-C-0 –Generic Telecommunications Cabling for Customer Premises
  - 4. ANSI/TIA/EIA-568-C-1 - Commercial Building Telecommunications Cabling Standard
  - 5. ANSI/TIA/EIA-568-C-2 - Commercial Building Telecommunications Cabling Standard - Balanced Twisted-Pair Cabling Components
  - 6. ANSI/TIA/EIA-568-C-3 - Optical Fiber Cabling Components Standard
  - 7. TIA – 569-B *Commercial Building Standard for Telecommunications Pathways and Spaces*, 2004
  - 8. ANSI/TIA/EIA – 606-A *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*, 2002
  - 9. ANSI-J-STD – 607-A *Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*, 2002
  - 10. NFPA 70 – *National Electric Code*, 2008
  - 11. BICSI – *Telecommunications Distribution Methods Manual*, 12<sup>th</sup> Edition, 2009

1.3 SUBMITTALS

A. Provide product data for the following:

1. Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

PART 2 – PRODUCTS

2.1 WALL-MOUNT BUSBARS

A. Telecommunications Main Grounding Busbar (TMGB)

1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 4" (100 mm) high and 20" (510 mm) long and shall have 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), or equal
  - b. Telecommunications Main Grounding Busbar:  
Part Number 40153-020, 20" x 4" (510 mm x 100 mm) Telecommunications Main Grounding Busbar, UL Listed. Or equal

B. Telecommunications Main Grounding Busbar (TMGB)

1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 4" (100 mm) high and 12" (300 mm) long and shall have 18 attachment points (two rows of 9 each) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), or equal
  - b. Telecommunications Main Grounding Busbar:  
Part Number 40153-012, 12" x 4" (300 mm x 100 mm) Telecommunications Main Grounding Busbar, UL Listed. Or equal

C. Telecommunications Grounding Busbar (TGB)

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 2" (50 mm) high and 12" (300 mm) long and shall have 9 attachment points (one row) for two-hole grounding lugs.

3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 6 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), or equal
  - b. Telecommunications Grounding Busbar:  
Part Number 13622-012, 12" x 2" (300 mm x 50 mm) Telecommunications Grounding Busbar, UL Listed. Or equal

D. Telecommunications Grounding Busbar (TGB)

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 2" (50 mm) high and 10" (250 mm) long and shall have 7 attachment points (one row) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 4 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Telecommunications Grounding Busbar:  
Part Number 13622-010, 10" x 2" (250 mm x 50 mm) Telecommunications Grounding Busbar, UL Listed. Or equal

2.2 RACK-MOUNT BUSBAR

A. Horizontal Rack Busbar

1. Horizontal rack-mount busbar shall be constructed of 3/16" (4.7 mm) thick by 3/4" (19.1 mm) high hard-drawn electrolytic tough pitch 110 alloy copper bar.
2. Bar shall be 19" EIA or 23" rack mounting width (as specified below) for mounting on relay racks or in cabinets.
3. Bar shall have eight 6-32 tapped ground mounting holes on 1" (25.4 mm) intervals and four 0.281" (7.1 mm) holes for the attachment of two-hole grounding lugs.
4. Each bar shall include a copper splice bar of the same material (to transition between adjoining racks) and two each 12-24 x 3/4" copper-plated steel screws and flat washers for attachment to the rack or cabinet.
5. Bar shall be UL Listed as grounding and bonding equipment.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Horizontal Rack Busbar:  
Part Number 10610-019, Ground Bar for 19" Rack.

## 2.3 BONDING ACCESSORIES

### A. Two Mounting Hole Ground Terminal Block

1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
3. The conductors shall be held in place by two stainless steel set screws.
4. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
5. Ground terminal block shall be UL Listed as a wire connector.
6. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Two Mounting Hole Ground Terminal Block:
  - c. Part Number 40167-001, Two Mounting Hole Ground Terminal Block, 1 each

### B. Compression Lugs

1. Compression lugs shall be manufactured from electroplated tinned copper.
2. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
4. Compression lugs shall be UL Listed as wire connectors.
5. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Compression Lugs:
    - (1) Part Number 40162-901, Compression Lug, #6 Awg, 5/8" (15.8 mm) hole spacing, 1 each.
    - (2) Part Number 40162-903, Compression Lug, #6 Awg, 1" (25.4 mm) hole spacing, 1 each.
    - (3) Part Number 40162-904, Compression Lug, #2 Awg, 5/8" (15.8 mm) hole spacing, 1 each.
    - (4) Part Number 40162-907, Compression Lug, #2 Awg, 1" (25.4 mm) hole spacing, 1 each.
    - (5) Part Number 40162-909, Compression Lug, 2/0 Awg, 1" (25.4 mm) hole spacing, 1 each.
    - (6) Part Number 40162-911, Compression Lug, 4/0 Awg, 1" (25.4 mm) hole spacing, 1 each.

### C. C-Type, Compression Taps

1. Compression taps shall be manufactured from copper alloy.
2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
4. Compression taps shall be UL Listed.
5. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Compression Taps:
  - c. Part Number 40163-001, Compression Tap, #6 AWG Solid Run to #6 AWG Solid Tap, 1 each.

- d. Part Number 40163-007, Compression Tap, 2/0 Stranded Run to 2/0 Stranded Tap, 1 each.

D. Equipment Ground Jumper Kit

1. Kit includes one 24"L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 ounce tube of antioxidant joint compound.
2. Ground conductor is an insulated green/yellow stripe #6 AWG wire
3. Lugs are made from electroplated tinned copper and have two mounting holes spaced .5" to .625" apart that accept 1/4" screws.
4. Jumper will be made with UL Listed components
5. Design Make shall be:
  - a. Chatsworth Products, Inc. (CPI), Or equal
  - b. Equipment Ground Jumper Kit:
  - c. Part Number 40159-010, Equipment Ground Jumper Kit, 1 each.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Wall-Mount Busbars

1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

B. Rack-Mount Busbars and Ground Bars

1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
2. Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer's installation instructions.
3. Bond the rack-mount busbar or ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.

C. Ground Terminal Block

1. Every rack and cabinet shall be bonded to the TMGB or TGB.
2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.



D. Equipment Ground Jumper Kit

1. Bond equipment to a vertical rack-mount busbar or groundbar using ground jumper according to the manufacturer's recommendations.
2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or groundbar to help prevent corrosion at the bond.

END OF SECTION

SECTION 27 11 16 COMMUNICATIONS CABINETS, RACKS, ENCLOSURES

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.
- B. Included in this section are the minimum composition requirements and installation methods for the following:

1.2 SCOPE OF WORK

- A. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Closets).

1.3 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- C. Material and work specified herein shall comply with the applicable requirements of:
  - 1. ANSI/TIA/EIA – 568-C Commercial Building Telecommunications Cabling Standard, 2000/2004 TIA – 569-B Commercial Building Standard for Telecommunications Pathways and Spaces, 2004.
  - 2. ANSI/TIA/EIA – 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2002 ANSI-J-STD – 607-A Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002 NFPA 70 – National Electric Code, 2005.

1.4 SUBMITTALS

- A. Provide product data for the following:
  - 1. Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

PART 2 – PRODUCTS

2.1 EQUIPMENT RACKS, SEISMIC-RATED

- A. Free Standing Relay Racks (Seismic Frame® Two-Post Rack)
  - 1. Racks shall be rectangular in shape, manufactured from steel, welded construction with two pairs of removable (bolt-on) equipment mounting rails.
  - 2. The top of the rack shall be pre-punched with attachment holes for cable runway and a top-mount cable management jumper tray. The sides of the rack shall be pre-

- punched with attachment points for power strips, snap-on cable guides and vertical cable managers. The bottom of the rack shall be pre-punched with attachment points for a junction box and attachment to the floor.
3. Equipment mounting rails shall be L-shaped, set 6" (150 mm) or 3" (80 mm) apart and punched on the front flange with the EIA-310-D Universal hole pattern to provide 44 rack-mount spaces for equipment. Each mounting space shall be marked and numbered on the mounting rails. Mounting rails shall be removable and reversible so that RMU numbering can start at the bottom or top of the rack.
  4. Equipment-mounting rails shall be horizontally spaced to allow attachment of 19" EIA rack-mount equipment. Attachment points shall be threaded with 12-24 threads. Each rack shall include 50 each combination pan head, pilot point equipment mounting screws.
  5. The rack shall have two masked ground connection points located near the top and bottom of the frame and will include a ground terminal lug to attach ground conductors from the Telecommunications Grounding Busbar. Equipment mounting rails will bond to the rack through assembly hardware.
  6. The rack shall measure 7' (2.1 m) high, 24" (610 mm) wide and 15" (380 mm) deep at the base. The sides of the rack frame shall be 9.6" (294 mm) deep.
  7. The rack shall be rated for 1,000 lb (453.6 kg) of equipment in seismic areas and meet Telecordia Technologies GR-63-CORE Network Equipment Building Systems (NEBS) Zone 4 requirements.
  8. Finish shall be epoxy-polyester hybrid powder coat in the color as specified below. Mounting rails will be painted to match or zinc-plated.
  9. Design Make: Chatsworth Products, Inc. (CPI), Seismic Frame<sup>®</sup> Two-Post Rack or equal
    - a. Part Number 13853-703, Seismic Frame<sup>®</sup> Two-Post Rack, 19"W x 7'H (2.1 m), 44 RMU, Tapped #12-24 Zinc Rails, Black.
    - b. Part Number 13702-001, Concrete Floor Anchor Kit, Zinc *(Includes four M12 x 5-1/8"L Hilti HSL-3 Heavy Duty Sleeve Anchors.)*

B. Cable Management (SeismicFrame<sup>®</sup> Two-Post Rack Vertical Cabling Section)

1. Each rack shall have a minimum of one double-sided vertical cable manager attached to the side of the rack. The cable manager will have separate front-facing and rear-facing C-shaped troughs to hold cables. The troughs will attach to the rack with slotted brackets that allow the troughs to be adjusted in depth and positioned to align with the front and rear of the rack. When positioned to align with the front and rear of the rack, there will be a space between the troughs along the side of the rack. Each trough will have large, plastic edge-protected openings along the sides to allow cables to enter/exit the trough and connect to equipment on the front/rear of the rack. Plastic spin-open latches at the front of each trough will secure cables in the trough. Large, edge-protected, rectangular openings at the rear of the trough will allow cables to exit the rear of the trough. The rear of the troughs will also be punched with keyhole slots to support power strips in the space in between the front and rear trough. Each cable management trough shall measure 7' (2.1 m) high, 6" (150 mm) wide and 6.3" (162 mm) deep at the base. Two troughs are included with each vertical cable manager.
2. Snap-on plastic cable guides with T-shaped dividers and openings that align with each RMU space on the rack shall be attached to the front side of each rack next to the vertical cable managers to provide by-RMU cable management for cables entering/exiting the rack.
3. A U-shaped cable management jumper tray shall be attached to the top of each rack to provide a side-to-side/rack-to-rack pathway for cables. The trough shall be 6" (150

mm) wide and 5.2" (132 mm) deep; shall align with the front-facing vertical cable mangers and shall have a formed radius to support cables where cables enter/exit the trough.

1. Finish shall be epoxy-polyester hybrid powder coat in the color as specified below. Plastic edge protectors, spin-open latches and snap-on cable guides are black.
10. Design Make: Chatsworth Products, Inc. (CPI), Seismic Frame Two-Post Rack Vertical Cabling Section or equal
- 2.

### PART 3 – EXECUTION

#### 3.1 INSTALLATION

##### A. Free Standing Relay Racks

1. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
2. All racks must be attached to the floor in four places using appropriate seismic-rated floor mounting anchors in the slab beneath the raised floor, and extended up through the raised floor with all-thread. See MFG recommended procedures for mounting in raised floor conditions. Additional bracing may be required by building codes and the recommendations of a licensed structural engineer. *Note: Seismic installations require additional bracing of racks, cabinets and overhead cable runways to building structure as advised by and certified by a licensed structural engineer.*
3. Racks shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).
4. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.
5. The equipment load shall be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws.

END OF SECTION

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SECTION 27 40 00 - AUDIO-VIDEO COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provisions of Division 1 apply to this section.
- B. Section Includes
  - 1. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Audio, Video and Control Systems work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems. General design intent for this project is shown on the drawings and described in the specification.
  - 2. All equipment requiring coordination with other trades must be tested and verified for proper operation. Contractor is fully responsible for the coordination and must resolve all conflicts with AV equipment that connect or interact with other systems.
  - 3. Design, engineer and provide complete means of support, suspension, attachment, fastening, bracing, and seismic restraints (hereinafter "support") of the Work of this Section, including future installed equipment, in accordance with local building codes and regulations. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Contractor shall obtain the services of an engineer licensed to perform this work within the state or jurisdiction it is to be performed.
  - 4. The Contractor shall include all costs associated with structural engineering required by code for work in this section.
  - 5. Use skilled mechanics that are capable of returning surfaces to the appearance of new work when modifying millwork.
  - 6. Conduit and common back boxes including four square, pull boxes, junction boxes, etc. are supplied and installed by Division 26 Electrical Contractor.
  - 7. Provide all cable and wire associated with this specification section and related documents.
  - 8. All systems shall be completely installed with all of the necessary interconnection, power supplies, patch cords, snakes, portable equipment cables and wiring to provide a fully functioning system.
  - 9. The governing overall requirement for this project is a complete and functional system.
  - 10. Include work not usually shown or specified, but necessary for proper installation and operation of the system or piece of equipment.
- C. Products Supplied But Not Installed Under This Section
  - 1. Loose equipment or products supplied but not installed shall be turned-over to the Owner immediately upon delivery. Contractor is to supply a signed statement of transfer of this equipment to the consultant for record. Client must sign this statement acknowledging receipt of this equipment.
  - 2. Specialty floor boxes, back boxes including but not limited to Crestron, AMX, Extron, FSR, Steel City and speaker back boxes shall be provided to the General Contractor for installation.
- D. Products Installed But Not Supplied Under This Section
  - 1. Owner Furnished and existing equipment as shown on drawings.
- E. Related Sections
  - 1. Division 9.

2. Division 10.
3. Division 11.
4. Division 26.

F. Allowances

1. Refer to section 2.1.E for related requirements.

G. Measurement Procedures

1. Product quantity is as required. If a quantity is given, the Contractor will provide at least the given amount. Some products listed under this section may not be required to fulfill the obligations of the work.

## 1.2 REFERENCES

A. Comply with all applicable governing codes.

B. Comply with the following applicable organizations and standards:

1. AES Audio Engineering Society
2. ANSI American National Standards Institute
3. ASTM American Society for Testing and Materials
4. BICSI Building Industry Consulting Service International, Inc.
5. BTSC Broadcast Television Stereo Committee
6. CEDIA Custom Electronic Design and Installation Association
7. EIA Electronic Industries Alliance
  - a. RS-310-C: (ANSI C83.9) Racks, Panels, and Associated Equipment
  - b. RS-453: Dimensional, Mechanical, and Electrical Characteristics Defining Phone Plugs and Jacks
8. ETL Electrical Testing Laboratories, Inc.
9. FCC Federal Communications Commission
10. ICIA International Communications Industries Association
11. IEC International Electrotechnical Commission
12. IEEE Institute of Electrical and Electronic Engineers
13. INCITS InterNational Committee for Information Technology Standards
14. ISO International Organization for Standardization
15. ITU International Telecommunications Union
16. NAB National Association of Broadcasters
17. NCTA National Cable and Telecommunications Association
18. NEC National Electrical Code
19. NEMA National Electrical Manufacturers Association
20. NFPA National Fire Protection Association
21. NSCA National Systems Contractors Association
22. OSHA Occupational Safety and Health Administration
23. SMPTE Society of Motion Picture and Television Engineers
24. TASO Television Allocation Study Organization
25. TIA Telecommunications Industry Association
26. UBC Uniform Building Code
27. UL Underwriters Laboratories Inc.

## 1.3 DEFINITIONS

A. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:

1. Frequency Response: The minimum acceptable frequency band over which the amplitude response is within 3 dB (or any specified range), or the specified limits of the response relative to the reference frequency (1 kHz for audio, 1.0 MHz for video)

- under design load conditions, at any operating level up to and including the specified maximum output while fully in compliance with all other performance specifications.
2. Maximum Output Level: The minimum acceptable maximum signal output level (voltage, current or power) attained under design load conditions attained while fully in compliance with all other performance specifications.
  3. Harmonic Distortion: The maximum acceptable harmonic distortion measured at any operating level, up to and including the specified maximum output, with an applied sine wave signal of any frequency in the range of the specified frequency response.
  4. Audio Intermodulation Distortion: The maximum acceptable intermodulation distortion resulting from the introduction of 60 Hz and 7 kHz signals in a ratio of 4:1 under design load conditions at any operating level up to and including the specified maximum output level.
  5. Signal to Noise Ratio: The minimum acceptable ratio of signal to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.
  6. Clipping Level: The minimum acceptable maximum level of signal applied to the device under design load conditions while fully in compliance with all other performance specifications.
  7. Sensitivity: The maximum acceptable level of input signal applied to the device that is necessary to provide the maximum output under design load conditions.
  8. Design Load: The load (in ohms) specified by usage of the particular device input or output.
- B. Signal Levels: The following voltage levels shall be considered the standard operating levels for the particular circuitry, unless specifically noted otherwise (0.775 Volt = 0 dBu = 0 dBm for a 600 ohms terminated circuit):
1. Microphone Circuits: -30 dBu or less.
  2. Audio Line Level Circuits: -30 dBu to +24 dBu; equivalent to -30 dBm to +24 dBm for a 600 ohms terminated circuit.
  3. Loudspeaker Level Circuits: More than +24 dBu.
  4. Video Line Level Circuits: 1.0 Volt, peak to peak composite signal.
  5. Radio Frequency (RF), Television (MATV) Circuits: +6 to +72 dBmV (0 dBmV = 1,000 microvolts).
- C. Characteristic Impedances: The following operating impedances shall be considered to be the standard operating impedances for the particular circuitry, unless specifically noted otherwise:
1. Microphone Circuits: 50-250 ohms source, 150-1500 ohms terminating, electrostatically and electromagnetically balanced to ground.
  2. Audio Line Level Circuits: 600 ohms maximum source, 600 ohms minimum terminating, line to line, electrostatically and electromagnetically balanced to ground.
  3. Video Line Level Circuits: 75 ohms maximum source, 75 ohms minimum terminating to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.
  4. Radio Frequency (RF) Television Circuits: 75 ohms nominal to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.
- 1.4 SYSTEM DESCRIPTION
- A. Design Requirements
1. General
    - a. The Pico Library audio-visual system includes a paging system for the library and an audio visual presentation system for the Community room.
    - b. A zoned public address system will be provided in library. Distributed 70-volt speakers shall be utilized to provide sound reinforcement. The audio system shall include a DTMF module that will act as an interface between the paging



system and the telephone system. Dialing a pre-defined sequence of numbers into the telephone will allow an all page to occur. Library speaker level control will be done at the power amplifier in IT rack. Pages will be made via the telephone system.

2. Community Room

- a. In-wall stereo speakers will be provided for sound reinforcement of voice and program material. The majority of the energy from the lectern microphone must be routed to the speaker furthest away from the lectern to allow greater gain before feedback. Contractor is to field calibrate the power distribution to the left and right loudspeakers that will allow the greatest gain before feedback from the lectern microphone.
- b. Microphones inputs will be provided at a floor box and facility panel.
- c. A single channel wireless microphone is provided to allow presenter the ability to move about the room.
- d. Input panels both floor and wall mounted will allow connection of laptop computer and portable audio-video equipment to the system.
- e. A lectern with gooseneck microphone and connection panel shall be provided for presentation purposes.
- f. A video projector will be used to project general video media and computer presentation material onto a motorized roll-down front projection screen. The video projector will be wall mounted per the drawings. Suitable seismic restraints shall be provided as required by code. A motorized front projection screen will be mounted recessed into the ceiling.
- g. Source equipment will include a blu-ray player with integrated tuner and broadcast television feed.
- h. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions. Control system will also control room functions including the motorized shades and lighting.
- i. A dockable wall mounted control touch panel will be used to interface with the main system controller.
- j. An assistive listening system shall be provided to satisfy ADA requirements.

3.

B. Software Programming

1. General

- a. Except when otherwise agreed in writing the client shall retain legal and beneficial ownership of all Intellectual Property, including source code, created by the Contractor, their employees and sub-contractors.
- b. The Contractor must allow sufficient time for the programming of all software configurable audio, video and control systems. Contractors must evaluate the systems functional requirements and user interface and then allow time in their bid accordingly. The system description as well as the end user interview will provide the Contractor with the necessary information needed to proceed with the programming. Any questions as to the systems functional requirements must be sent in written RFI form to the Consultant. All programming schemes must be submitted to the Consultant for approval before programming starts. This includes the appearance of all user interfaces, touch panel layouts, preset and sub-preset information (acquired through client interviews), and speaker control schemes. The Contractor will also submit a narrative for the control system concept to the Consultant for approval. The Contractor is to interview the Owner and their representatives to acquire the necessary information needed to allow for the proper programming of this system. The Contractor, after interviewing the Owner, will then submit a written report stating his interpretation of the client's requirements for approval by Consultant. Only after the Client and Consultant have approved the programming report may the Contractor proceed with the programming of this system.

- c. All equipment that is connected to the Client's local area network and is configurable via the local area network must have its equipment software installed onto dedicated computers provided by the Client. The Contractor is to allot time to install and test equipment software onto a minimum of two of the Client's computers which are to be identified by the Client and/or Consultant. The computers will be programmed to emulate user interfaces throughout the facility. The Contractor shall coordinate all software deployment over IP with the Client's Information technology department.
- 2. Control system minimum programming outlined below:
  - a. The Contractor shall allot 4 hours for on-site control system programming with the Client's representative.
  - b. The Control System in this project shall connect to the Client's Local Area Network (LAN). This connection will provide desktop computers control of the audio-visual system as well as make available remote troubleshooting via the internet. The Contractor shall provide time to install control system interface software on at least three desktop computers. Coordinate work with Client's Information Services personnel.
  - c. Provide password protection to each control surface in this facility. Pushbutton panels shall be activated by holding the lower two buttons down for 5 seconds. Deactivation will automatically take place 120 seconds after control panel was last gestured. APADs will be activated by holding two buttons down for 5 seconds. Deactivation will automatically take place when the system is shutdown. Touch panels shall be activated and deactivated by password. Upon start up a password dialog box shall be presented to the user to enter his/her password. Only after entering a password will the user have access to the system. The system shall be programmed to shut down automatically after being idle for a time to be specified by the user. A separate password shall be programmed for all dockable touch panels. This password shall allow the user to undock the touch panel. Coordinate this feature with operations staff.
  - d. All push button control panels shall be programmed with a technical user mode that allows technical personnel to access a second level of control. A push button volume adjust/source select control interface usually includes various sources that may be played into the zone under control. These sources enter a mixer in the DSP allowing control of both input and output of this mixer. Normal, user level, operation of volume control at a push button station will permit only the output of the mixer to be controlled. This allows a user the ability to control the output of the mixer to raise and lower the volume of all source devices simultaneously. Pressing any of the source select buttons for at least five seconds will place the unit into technical mode and allow technical personnel access to a second level of control functionality. This will permit a technician to balance levels at the inputs of the mixer when required. Holding down a source button for five seconds allows input volume control for sixty seconds. The input source select button will flash during this time period. Pushing another source button for five seconds will immediately release the previously selected button. Selecting a source button for less than five will switch to that source but only the output volume control will be affected by the volume up and down buttons. After sixty seconds of inactivity the panel will automatically default back to user level control.
  - e. Touch panel layout design will conform to the InfoComm International "Dashboard for Controls" guidelines. Touch panel designs are to be custom to this project. Re-purposed touch panel designs are not acceptable.
  - f. Technical users shall have the ability to access individual speaker zone controls via the touch panel interface.
  - g. Control Help File: Each touch panel will include a help file that will explain each layer of the touch-panel control scheme.
  - h. Control system shall utilize help desk software to provide:

- 1) Real-time monitoring of:
    - a) Control system.
    - b) Device monitoring.
    - c) Projector lamp life.
    - d) System online status.
    - e) Room activity.
  - 2) Remote system diagnostics via Contractors help desk.
  - 3) Remote system control.
  - 4) Event scheduling.
  - 5) Fault reporting via email alert.
  - 6) Logging of help request.
  - 7) User access control via password protection.
  - 8) Event logging, report and chart generation.
  - i. The help desk software shall be placed on the desktop computers of each audio-visual maintenance person as well as key personnel of the Client. The Contractor shall train maintenance and operations persons to use this software feature.
  - j. All serial controlled devices must have bi-directional communication with the control system. All control functions locally available on each device must be accessible via the remote control system. All locally gestured control functions must mirror on the control system user interface. In other words, if a volume control is adjusted on a DSP interface that adjustment must register on the control interface.
  - k. Control system shall be used to power up and down connected equipment.
  - l. All projectors shall be monitored and report lamp hours remaining and lamp failure.
3. Complexity of Programming:
- a. It is required that the Contractor be experienced in programming systems of this complexity. Contractors shall allow enough time in their bid to permit extensive programming of all software configurable audio, video and control systems to the requirements of the client and consultant. Contractor shall break out cost associated with programming of these systems for review by the Consultant. By submitting this bid, the Contractor agrees that they understand systems of this type and that all programming services are included to the satisfaction of the Consultant. The Contractor further agrees that they will not make any claim for additional monies because of misinterpretation of programming requirements.

C. System Performance Standards and Requirements (meet or exceed)

1. Audio Systems:
  - a. Electrical Performance; Source Input to Power Amplifier Output:
    - 1) Frequency Response (Equalizer flat): +/- 0.2 dB 20 Hz to 20 kHz.
    - 2) Total Harmonic Distortion (THD): Less than 0.05%, 20 Hz to 20 kHz, 4 ohms.
    - 3) Noise: At least -105 dB, 20 Hz to 20 kHz, referenced to input of +4 dBm.
    - 4) Crosstalk: At least -60 dB, 20 Hz to 20 kHz.
    - 5) Damping Factor: Greater than 500 (below 1 kHz)
  - b. Electro/Acoustic Performance; Distributed Systems: 103 dB Consistent with devices specified herein.
    - 1) Equipment: Specified individually.
    - 2) Audio signal paths: Shall not degrade performance of connected equipment.
  - c. NEC - Article 640: Audio Signal Processing, Amplification and Reproduction Equipment.
2. Video Systems:
  - a. Video signal system: NTSC to EIA RS-170A, except as noted.

- b. Video signal paths: To EIA RS-250C short haul where equalized or fiber optic transmission, otherwise to the performance limit of the specified video cable.
- c. ANSI IT7.228 (ANSI Lumens): Measurement method for light output of fixed resolution video projection systems.
- d. ANSI IT7.228 (ANSI Contrast Ratio): Measurement method for the contrast ratio of fixed resolution video projection systems.
- e. SMPTE 170M: Color Specification for NTSC.
- f. SMPTE 125M: Universal Sampling spec for SDTV and HDTV Broadcast Video.
- g. SMPTE 253M: RGB Analog Video Interface spec for SDTV Studio applications.
- h. SMPTE 274M: Component spec for 1920 x 1080 HDTV.
- i. SMPTE 296M: Spec for 1280 x 720 RGB and YPbPr Baseband Video.
- 3. MATV/CATV RF Systems run in common raceway with Sound and Audio-Visual cabling shall meet the following performance requirements:
  - a. Radiation: Comply with Title 47, Code of Federal Regulations, Part 76, Cable Television Rules and Regulations.
  - b. The system shall provide interference-free distribution of any of the scheduled CATV Utility channels and any of the internally generated channels.
  - c. The TASO Grade of the signal of any channel when viewed on a standard commercial TV receiver at any tap-off outlet shall not be less than the TASO Grade of the same channel viewed on the same receiver when connected directly to the MATV System feed.
  - d. The signal level from any channel to any adjacent channel shall not vary more than 3 dB at the tap-off output.
- 4. Data and Communications Systems:
  - a. TIA/EIA 568-C series: Commercial Building Telecommunications Cabling Standard.
  - b. ANSI J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
  - c. Comply with ITU-T (International Telecommunications Union – Telecom) for video conferencing systems.
- 5. Control Systems:
  - a. RS485 (TIA-485): Electrical characteristics of generators and receivers for use in balanced digital multipoint systems.
  - b. RS232 (TIA-232): Interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.
  - c. RS 422 (TIA-422): Electrical characteristics of balanced voltage digital interface circuits.

## 1.5 SUBMITTALS

### A. General

- 1. In addition to the requirements of Division 1, submit all materials for review arranged in the same order as the Specification, individually referenced to the Specification paragraph and Contract Drawing number. Submit 8 1/2" x 11" items bound in volumes and drawings in edge-bound sets. Submit all drawings on sheets of the same size.
- 2. The Contractor is to provide two copies of each hardcopy submittal and an electronic format copy (Shop drawings must be submitted as .DWF. All other submittals will be provided as .PDF).
- 3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.

4. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception Taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
  5. In the event that the Contractor deviates from the design shown on the audio-visual Contract Documents when preparing their shop drawings, the Contractor shall indicate with architectural style clouding, those deviations. The Contractor shall also submit with the Shop Drawings, a list of those deviations and substitutions, including the following:
    - a. The deviation item number which shall also correspond to a number designation applied to each cloud on the shop drawings.
    - b. Section of the specification that applies to these changes.
    - c. The applicable shop drawing sheet number for each item.
    - d. The corresponding audio-visual Contract Document sheet number for each item.
    - e. A clear description of the deviation.
    - f. The Contractor's rationale for the deviation (i.e. what benefit the deviation provides, why it is required, any cost impact, etc.).
- B. Infrastructure
1. Provide drawings indicating boxes conforming and non-conforming to Consultant's AV drawings.
- C. Product Data
1. Manufacturer's Product Data
    - a. Contractor is to submit submittal in electronic format (i.e. PDF)
    - b. List of materials (i.e. Table of Contents) categorized by room type: For each item specified in PART 2, include:
      - 1) Drawing device ID code.
      - 2) Manufacturer.
      - 3) Model number.
      - 4) Listing: UL or other lab.
      - 5) Quantity.
    - c. In sequence of List of Materials, provide a data sheet for each item, including all accessories marked for the proposed product.
- D. Shop Drawings
1. Field (Installation) Drawings: Collate in sequence:
    - a. Contractor is to submit shop drawings in .DWF format.
    - b. Drawing index/symbol sheet.
    - c. Floor plans. At scale of Contract Documents. Show:
      - 1) Device rough-in boxes with ID number.
      - 2) Mounting height.
      - 3) Conduit size.
      - 4) Wire type.
      - 5) Wire fill.
    - d. Sections/Elevations. At scale of Contract Documents:
      - 1) Mounting location reference to nearest gridline.
        - a) Provide sections for each room containing AV equipment.
        - b) Provide elevations for each wall in rooms containing AV equipment.
        - c) Show all equipment, including speakers, monitors, projectors, podium, floor boxes, facility boxes, etc.
        - d) Provide vertical dimensions referenced above finished floor to each piece of equipment.
        - e) Provide horizontal dimensions reference to gridlines.

- e. Enlarged Plans. At scale of Contract Documents or larger as required for trade coordination. Show:
  - 1) Items indicated in "floor plans" above.
  - 2) Architectural features.
  - 3) Rack cabinets.
    - a) Ventilation details.
    - b) Power distribution detail.
  - 4) System furniture.
  - 5) Clearances required by applicable Code.
- f. System Conduit Riser Drawing, Show:
  - 1) Terminal cabinets.
  - 2) Coordination with floor plans.
  - 3) Wire runs not shown on floor plans.
  - 4) Wire type.
  - 5) Wire fill.
- g. Mounting details:
  - 1) Stamped and signed by an Engineer licensed in the Project jurisdiction for work of this type, where required by code.
  - 2) Show loads, type and strength of connections, sizes, dimensions, materials, etc.
  - 3) Show calculations on drawings or in bound volume for review by Authorities having jurisdiction.
  - 4) Provide details for:
    - a) Equipment rack anchorage.
    - b) Loudspeaker mounts.
    - c) Video projector mounts.
    - d) Projection screens, both fixed and motorized.
    - e) Attachment to building structure.
- h. Installation details as required:
  - 1) Terminal cabinets: Terminations.
  - 2) Audio-Visual panel details.
- i. Wire run sheets. Show:
  - 1) Wire number.
  - 2) Source.
  - 3) Designation.
  - 4) Signal type.
  - 5) Wire type.
  - 6) Operating level or voltage.
  - 7) Timing reference, where applicable.
  - 8) Physical length.
- 2. Shop (Fabrication) Drawings: Collate in sequence:
  - a. Contractor is to submit shop drawings in .DWF format.
  - b. Drawing index/symbol sheet (if separate set from Field Drawings).
  - c. System functional drawings. Submit separate drawings for each system/subsystem. Show at least:
    - 1) Equipment:
      - a) Function, make, model.
      - b) Rack number, module frame and slot number.
    - 2) Field device information
      - a) Terminal cabinets.
      - b) Pull boxes.
      - c) Audio-visual panel connector designations.
    - 3) Wiring
      - a) Wire number.
      - b) Wire type.
    - 4) Shield condition at both ends (float, ground, location of ground).

- 5) Connector wiring details, each type.
- 6) Audio: Nominal operating level, Polarity. Note deliberate polarity inversions where required to maintain absolute polarity.
- 7) Video: Physical length. Electrical length in nanoseconds or degrees of sub-carrier, as applies. Equalization required.
- 8) Twisted pair, transmit and received devices: Transmission range at 60 Hz., cable length and signal quality.
- d. Provide drawings for the following systems, if applicable:
  - 1) Audio.
  - 2) Video.
  - 3) Control.
  - 4) Data transmission.
  - 5) Coordinated grounding scheme.
- e. Equipment rack elevations: Show:
  - 1) All racks scaled at 1 1/2" equals 1 foot, or larger.
  - 2) Rack: Make, model.
  - 3) Equipment: Function, make, model.
- f. Rack wiring drawings: For each rack, show:
  - 1) Power strip: Receptacles, circuiting.
  - 2) Sequencing power and surge suppression systems.
  - 3) Equipment.
  - 4) Grounding.
  - 5) Wiring, all systems.
  - 6) Wiring harness scheme.
  - 7) Ventilation detail.
- g. Fabrication details: Submit for:
  - 1) Receptacles.
  - 2) Panels.
  - 3) Special mounting provisions.
- h. Legends/engraving details. Half or full size:
  - 1) Receptacles.
  - 2) Audio-visual panels.
  - 3) Equipment designations.

E. Samples

1. Of all finishes/materials that will be visible to the public, including but not limited to:
  - a. Receptacles and controls with associated trim plate.
  - b. Each type of loudspeaker baffle and/or grille.
  - c. All audio-visual panels.
  - d. Audio-visual devices in public areas.

F. Programming

1. Control Programming Scheme Submittal
  - a. Contractor is to submit submittal in electronic format (i.e. PDF)
  - b. Provide a password-protected link to a folder on the Contractor's network to remotely access the touch panel from the Consultant's computer. Contractor is to have a dedicated control processor utilized on their network.
  - c. Provide a graphic layout of each user control interface (touch panels, push buttons, etc.).
  - d. Provide a list of devices that are controlled by each control user interface, including:
    - 1) Device.
    - 2) Brand.
    - 3) Model Number.
    - 4) Control Method.
  - e. Provide a logic tree for each page for each control interface.

- f. Provide a system routing sheet for each control user interface, including:
    - 1) Source.
    - 2) Switcher / device input.
    - 3) Switcher / device output.
    - 4) Final destination.
  - g. Provide a narrative explaining the function of each control interface.
  - h. Provide help file content on each user interface.
- G. Shop and Project Site Test Reports
  - 1. Contractor is to submit submittal in electronic format (i.e. PDF)
  - 2. Schedule: Submit test reports in a timely manner relative to the Project schedule such that the representative of the Owner may conduct Verification of Submitted Test Data without delay of progress.
    - a. Shop test report: Submit prior to shipping completed equipment racks to Project Site.
    - b. Project Site test report: Submit project site test report for this section after system completion and prior to Acceptance Review and Testing.
  - 3. Content: Include at least:
    - a. Time and date of start of burn-in.
    - b. Time and date of test.
    - c. Personnel conducting test.
    - d. Test equipment, including serial and date of calibration.
    - e. Procedures used.
    - f. Results of test - numerical or graphical presentation.
- H. Close Out Submittal
  - 1. Contractor is to submit submittals in electronic format (i.e. PDF)
  - 2. Operation and Maintenance Manuals
    - a. Index.
    - b. Systems operating instructions.
    - c. Reduced set of system Record Drawings.
    - d. Key schedule.
    - e. Maintenance and spare parts schedules.
    - f. Shop and Field Test Reports.
    - g. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals in color for each equipment item. Provide tabbed dividers between each product. Manuals provided by the Manufacturer in an individual binder may be submitted in that form.
  - 3. Framed Operating and Maintenance Instructions: Provide adjacent to each ensemble of equipment racks. Provide sturdy frame with clear glass or non-scratching plastic cover. Provide permanent, non-fading media. Blueprints shall not be acceptable. Include:
    - a. Sequence for system start-up and shutdown.
    - b. System Functional Diagrams.
    - c. Signal levels and impedance at accessible system signal and test ports, where applicable.
  - 4. Record Drawings
    - a. As work progresses, maintain records of "as installed" conditions. Update the set at least weekly. After successful completion of Project Site testing specified herein, and after completion of Punch List corrections, copy all records of "as installed" conditions on to final Record Document drawings, as specified in Division 1.
    - b. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent



- signage differ from construction designations in the Contract Documents, show both designations.
5. Provide four copies on CD-ROM containing the "as built" drawings, all manuals, training manual and programming code.
    - a. Submit un-compiled programming code.
  6. Training Submittal
    - a. Provide all training materials for review prior to scheduling training sessions.
      - 1) Training manual.
      - 2) Agenda for the training session.
      - 3) The final punch list, indicating that all equipment is fully functional.
    - b. See the section under Owner's Instructions for training manual requirements.
    - c. No training session will be scheduled until final punch list is completed and submitted.
  7. Warranty Certificates
    - a. Comply with Division 1.

#### 1.6 QUALITY ASSURANCE

##### A. Qualifications

1. The bidder shall, prior to the bid, in accordance with the Instruction to Bidders, submit at least the following information to verify that the bidder has the necessary experience and qualifications to perform the specified work:
  - a. A detailed brochure describing the bidder's capabilities in terms of facilities, personnel (include a personnel organization chart followed by resumes), experience, background, examples of similar installations (at least two projects within the past two years), distribution arrangements with manufacturers and financial capability, including certificates of insurance and satisfaction of the project bonding requirements.
  - b. AIA Document A305 "Contractor's Qualification Statement".
  - c. Information identifying any and all local agents and/or subcontractors that will assist in the work and their role in the project.
  - d. Identification of sources of labor for all fabrication and installation throughout the duration of the project.
  - e. Evidence that he has acquired all necessary licenses, certificates and approvals to perform the specified work within the state or jurisdiction the work is to be performed.
2. Projects that include software configurable, integrated central control systems must include, as a sub-contractor, an authorized independent programmer who is fully engaged in the work of programming. This person shall hold a CAIP - Crestron Authorized Independent Programmer or ACE – AMX Approved Certified Expert.

The Contractor is to enter into an agreement utilizing the authorized independent programmer as a sub-contractor. Under this agreement, the Contractor will retain all of the responsibility for a complete and working system. The Contractor must include in their bid time to work out any programming glitches that may occur in the initial programming stage. These items include working through the initial and final programming stage with the authorized independent programmer to provide a functional system, testing the programmer's graphical user interface for intended functionality and provide on site support for the programmer in the uploading and testing of programming revisions. The control systems programmer shall be present either by phone or in person at the end user interviews to acquire information first hand. The control systems programmer shall submit a report outlining the meeting results to Contractor for approval. Only when the Contractor approves this report shall it be submitted to the consultant for review. If the contractor does not employ a fulltime programmer, the following companies have been approved subject to above.

  - a. CAIP – Crestron Authorized Independent Programmer.

- 1) Approved CAIP Programmers
  - a) Rolling Thunder Software  
San Diego P (760) 635-0370  
Las Vegas P (702) 564-2968  
[www.rollingthundersoftware.com](http://www.rollingthundersoftware.com)
  - b) TechSpa  
Joe Kurta P (407) 888-4466  
[www.techspa.net](http://www.techspa.net)
  - c) Korelogix  
Tom Fischer P (480) 235-6861  
[www.korelogix.com](http://www.korelogix.com)
  - d) Front Side Solutions  
Darryl Lovato P (714) 484-9486  
[www.frontsidesolutions.com](http://www.frontsidesolutions.com)
  - e) AV Programming Associates, Inc.  
Matthew Grisafe P (760) 632-6996  
[www.avprogramming.com](http://www.avprogramming.com)
  - f) BMA Software Solutions  
Marc LaVecchia P (714) 455-2717  
[www.bmasoftwarewaresolutions.com](http://www.bmasoftwarewaresolutions.com)
- b. ACE – AMX Certified Expert.
  - 1) Approved ACE programmers:
    - a) Front Side Solutions  
Darryl Lovato P (714) 484-9486  
[www.frontsidesolutions.com](http://www.frontsidesolutions.com)
    - b) Rolling Thunder Software  
San Diego P (760) 635-0370  
Las Vegas P (702) 564-2968  
[www.rollingthundersoftware.com](http://www.rollingthundersoftware.com)
    - c) TechSpa  
Joe Kurta P (407) 888-4466  
[www.techspa.net](http://www.techspa.net)
    - d) Korelogix  
Tom Fischer P (480) 235-6861  
[www.korelogix.com](http://www.korelogix.com)
3. The Contractor will provide information on how and by whom the requirements of the warranty period will be fulfilled.
4. The submittal must justify, in the judgment of the Consultant, the Architect, and the Owner, that the Contractor has the capability to manage and install a project of this size and scope and that he is capable of the necessary business and technical arrangements for this installation and the pursuant warranty service. Contractor may be disqualified as a bidder if all of the submittal does not meet the approval of the Owner and his/her representative.
5. Company: Work of this Section shall be performed by a Sound or Audio-Visual Systems Contractor who has at least five years direct experience with the devices, equipment and systems of the type and scope specified herein, and who has a fully staffed and equipped maintenance and repair facility, and who is licensed to perform work of this type in the Project jurisdiction. The company must be NSCA R-ESI or CTS certified.
6. Personnel: Use adequate numbers of skilled workers 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 of this Section. Supervisors shall have at least five years direct experience in similar work. Installation and maintenance personnel shall have at least three years direct experience in similar work. Contractors shall have at least 60% of their installation staff CTS or C-EST certified.

7. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual throughout the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.
  8. Staff Engineer: The Contractor shall have on his full-time payroll at least one staff engineer having five years minimum experience as an electronics engineer covering systems and projects comparable in substance and complexity to the project described herein. The staff engineer shall have NICET certification in Electrical/Electronics Engineering Technology and Audio Systems or equivalent. The signature of that engineer shall appear on all shop drawings and submittals.
  9. Coordination: Coordinate the Work of this Section with the Work of all other Separate Contracts. Comply with Division 1.
- B. Cutting and Patching
1. Cut, patch and extend existing work using skilled mechanics that are capable of matching existing quality of workmanship.
  2. Assign work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to cause least damage to each type of work, and provide means of returning surfaces to appearance of new work.
  3. Perform cutting and removal work to remove minimum necessary, and in a manner to avoid damage to adjacent work. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.
  4. When new work abuts or finishes flush with existing work, make a smooth and workmanlike transition. Patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible.
  5. Protect existing finishes, equipment, and adjacent work that are scheduled to remain, from damage.
  6. Promptly repair damages caused to adjacent facilities by demolition operations, at no change in Contract Amount.
- C. Painting
1. Use skilled mechanics that are capable of painting audio-visual equipment and hardware to match architectural surroundings, where applicable.
- D. Regulatory Requirements
1. Regulations Applicable: including but not limited to those defined in Division 1.
  2. Comply with all applicable federal, state, and local labor regulations, and applicable local union and trade regulations.
  3. Installation practices shall be in accordance to industry-accepted standards (ANSI, Cal-OSHA, IEC, IEEE, FCC, NEC, NFPA, ICIA, NSCA, CEDIA, BICSI) or local acts, codes and standards enforced at the place of work, whichever is most stringent.
  4. Procure and pay for all necessary permits, licenses, inspections, and observe any requirements stipulated therein.
  5. Provide UL/ULC fire rated enclosures around all audio-visual floor and back boxes where required by code.
- E. Programming
1. User Group Interview:
    - a. Conduct interviews with the end-users to acquire programming requirements. Submit written results of the interview and the requirements set forth by the user group. Associate the user group requirements into the programming of each sub system. Submit to the Consultant a report that outlines the interviews conducted.
- F. Pre-installation Meetings

1. Attend a pre-installation meeting at the project site with the Owner and his representatives in order to coordinate related work and scheduling issues.
  - G. Verification
    1. Verify dimensions and conditions at the Project Site. Submit any conflicts in timely manner for resolution.
  - H. Shop Fabrication and Testing
    1. Assemble and fully wire equipment racks at a fabrication shop off the Project Site. Burn-in for not less than 120 hours. Following burn-in, perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Submit verification of shop test in timely manner. Following verification of shop test and when installation locations are ready as specified herein, deliver equipment racks and equipment to the Project Site and install.
  - I. Project Site Installation and Testing
    1. Install as specified herein.
      - a. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of Project Site test in timely manner.
  - J. Verification of Submitted Test Data
    1. Re-test in presence of designated representative(s) of the Owner at reasonable mutual convenience. Provide services of the designated supervisor and an additional technician familiar with work of this Section. Provide all test equipment. Provide complete set of latest stamped submittals of record for reference. Provide complete set of Shop and Project Site Test Reports, as applies. Provide a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
  - K. Reference/Project Record Documents
    1. At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete set of the latest stamped, action submittals of record for reference. Also maintain a separate, clean, undamaged set for preparation of Project Record Documents. Also maintain at the workplace a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- 1.7 DELIVERY, STORAGE AND HANDLING
- A. Packing, Shipping, Handling and Unloading
    1. The Contractor will take receipt of all Owner Furnished Equipment at the project site or at a local warehouse.
    2. Deliver materials in manufacturer's original undamaged packages or in bulk packing which provides equivalent protection from rough handling, dust and dirt.
    3. All packing, shipping, insurance, handling and storage costs of equipment and materials shall be the responsibility of the Contractor.
    4. The Contractor shall be responsible for insuring all equipment and installation materials stored in their shop facilities until it is delivered to the Project Site and a delivery acknowledgement is received from the Owner or its authorized representative.
    5. Equipment unpacked for inspection but not ready for permanent installation must be returned into its protective packing.
    6. The Contractor shall be responsible for furnishing a temporary substitute for equipment that could not be delivered in time for system operation. All costs

associated for renting, shipping and handling temporary substitute equipment shall be the responsibility of the Contractor.

7. In the event the equipment or installation material delivery is delayed, the Contractor must employ the fastest means of delivery service available to deliver the equipment on time. All costs for expediting the delivery of equipment shall be the responsibility of the Contractor.
8. Store packaged materials off of the ground or slab in a manner to protect them from elements, especially moisture damage.
9. Deliver completed, wired, tested equipment racks to associated equipment rooms at the Project Site when major work of all other separate contracts is complete, equipment room ventilation is operating with clean filters in place, the area is clean and free from airborne contaminants, and continuing work of other trades will not produce airborne contaminants or permit transport of such airborne contaminants to the equipment rooms.

B. Acceptance at Site

1. All equipment and installation material delivered to the Owner shall be properly documented in the form of delivery receipts.
2. Equipment delivered to the Project Site must have a delivery acknowledgement receipt signed by the Owner or its representative. Issue a signed copy of the delivery receipt to the Owner and file the signed copy for future reference.
3. The Contractor shall be responsible for the insurance coverage and security of equipment delivered to the Project Site until it receives an acknowledgement of delivery from the Owner or its authorized representative.

C. Storage and Protection

1. The Contractor shall provide a safe and secure storage location for all equipment and installation materials until they are delivered to the Project Site and it receives an acknowledgement of delivery from the Owner or its authorized representative.
2. For equipment assembled and tested at the Contractor's shop facility and delivered to the Project Site, ensure that the equipment is properly protected from improper handling, rain, water, humidity, moisture, heat, direct exposure to sunlight, dust and dirt during delivery and storage on or off the Project Site.
3. Do not remove protective packing from equipment until they are ready to be installed.
4. If, after equipment is installed, the Project Site cannot be cleaned or is still not clean because of on-going work by others, provide protective covering and protection to prevent airborne dust and dirt originating from damaging equipment.

1.8 PROJECT SITE CONDITIONS

A. Environment Requirements

1. The spaces where audio-visual system assemblies are installed shall meet the following requirements:
  - a. Free from dust generated from construction.
  - b. The room temperature shall be within the specified operating temperature recommended by the manufacturer.

B. Existing Conditions

1. Contractor to verify existing site conditions.

1.9 SEQUENCING

- A. Submit all testing documentation to the Owner's Representative for review prior to requesting the Fabrication Inspection and Substantial Completion inspections.
- B. Allow adequate time for corrections to be made after inspections to maintain the Project

Schedule.

1.10 SCHEDULING

- A. Comply with the Project schedule.
- B. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section.
- C. Deliver all equipment, devices and materials required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen days prior to the completion date for the associated area of the Project, unless specifically instructed otherwise by the Owner.
- D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner, in lieu of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven days prior to the completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.
- E. It shall be a common understanding that there is a time constraint when executing this work. The Contractor shall use all means and resources to complete this project on or before the specified schedule at no additional cost to the Owner. This includes working beyond normal business hours and days, additional manpower, additional tools, etc.

1.11 WARRANTY SERVICE

- A. Warrant all Work of this Section to be free from defects in materials and workmanship for a minimum of 1 year from the date of Owner acceptance of the Work of this Section.
- B. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty may be voided. In such cases, provide a warranty equivalent to that of the original manufacturer.
- C. All high-level software shall follow the warranty conditions specified by the manufacturer. Immediately update or upgrade the Owner's installed software as soon as new versions, updates or patches become available from the manufacturer at no additional cost to the Owner within this warranty period.
- D. Response Time: Provide a qualified technician familiar with the work at the Project Site within 12 hours after receipt of a notice of malfunction. Provide the Owner with the telephone number attended 8 hours a day, 5 days a week, and an answering service or equivalent facility attended 24 hours a day, 7 days a week, to be called in the event of a malfunction. Provide repairs at no expense to the Owner and at the Owner's request, alternate facilities, services and systems for the duration of the repairs to any defective work of this Section. Provide a complete and operational System, within 48 hours after notification of a malfunction.
- E. All work requested due to warranty issues shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.
- F. The Contractor shall use qualified service personnel to respond to all warranty issues or calls.

- G. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute systems, equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts and personnel to and from the Project Site.

#### 1.12 OWNER'S INSTRUCTIONS

- A. General
  - 1. Conduct training on the completed system at a reasonable convenience of the Owner during normal Owner business hours. Contractor is to assess the complexity of the system and will be held responsible to fully train the operation and maintenance staff named by the Owner.
  - 2. Do not start training until all systems have been commissioned, training manuals are approved and an agenda along with schedule of each departmental training session has been submitted.
  - 3. Training will be conducted in the actual room that is the topic of the training session.
  - 4. The client asserts legal and beneficial ownership of all training materials which are specifically commissioned for this project.
- B. Operator Training – Do not start training before system is in full operation and all components have been signed off by owner's representative. Use the items covered in the commissioning portion of this specification as a basis for the training curriculum.
  - 1. At least two 4-hour sessions of instruction will be given in order to familiarize the Owner with the operation of the system. Each training session shall be videotaped. Use a digital conferencing system with dedicated microphone stations for the instructor and each student so that questions and their answers are clearly recorded. A video projector and screen will be used to view the user interface as it is explained. Camera and projector must be synchronized. Audio and video files shall be combined and burned to DVD for distribution to each department. Provide professional DVD with searchable index of topics covered. Provide label with client's logo, room name/number, title, length and topics covered. Provide training on at least all system features as outlined in the Commissioning section plus basic troubleshooting.
- C. Maintenance Training
  - 1. At least two 3-hour sessions of instruction will be given in order to learn how to maintain and troubleshoot the system. A maintenance binder shall be provided by the Contractor with all manufacturer-specific operating and maintenance information for each piece of equipment used. On large jobs, the binders will be sub-divided into individual audio, video and control binders. Provide training on at least the following system features:
    - a. Firmware upgrades
    - b. Helpdesk features
    - c. Complete use of system as outlined in the Commissioning section plus advanced troubleshooting.
- D. A training manual specific to this system will be written covering the basic and advanced functional techniques necessary to operate the system in a reliable and fully-functional condition. The Contractor will submit color copies of the training manual and a soft copy in PDF or DOC format. This manual will include:
  - 1. All contact information, including emergency and after hours phone and pager numbers, for requesting service assistance from the Contractor.
  - 2. A 11x17 set of as-built drawings of the completed project (a full-sized set will be issued to the client for their use, a half-size set will be attached to the inside back door of the main equipment rack).

3. A table of contents at the beginning of the manual.
    - a. The manual will begin by explaining basic information such as manual references, abbreviations, any assumptions made by the author, prerequisites required, numbering convention, etc.
    - b. It will then proceed to the manual objectives.
    - c. Explain what the end user should understand after reading the manual.
    - d. It will cover the basics of the user interface including start up and shut down procedures, log on procedures, access privileges, operator password, levels of security, file structure, etc.
    - e. The manual will proceed to describe each user interface and its function. It will cover every layer of the interface and how to navigate through them.
    - f. Each of the system presets will be explained and the physical setup of the equipment and floor plan during presets will be illustrated. Source equipment such as CD players, Cassette, VCR, etc. shall have their routing scheme explained and illustrated. Portable equipment and its connection to the system shall be explained and illustrated.
    - g. The manual will end by explaining basic troubleshooting procedures and equipment care instruction.
  4. The Contractor's maintenance instructions, which will include the manufacturer's maintenance instructions found on the factory manuals to keep the manufacturer's warranty in force.
  5. A list of consumables (lamps, fuses, batteries, etc.) required to keep the system operating over time, along with sources of supply (if not readily available).
  6. The Contractor will compile and submit all factory warranty registration forms or cards for each piece of equipment furnished for this project.
  7. A form requesting feedback from the end user as to how the manual should be improved and a section to report errors discovered.
    - a. The Contractor will make the corrections and improvement suggestions after receiving feedback from the users. This will be completed at no charge to the client. The manual will contain a date stamp and version number. Each feedback and error correction manual reissue will include a new version number.
- E. Initial Use Support
1. Provide standby trainer/system engineer during the first two public events.
- 1.13 MAINTENANCE
- A. The Contractor shall, within the warranty period, schedule two visits to inspect and perform preventive maintenance on the system. The first visit shall be six months after the commencement of the warranty period. The last visit shall be just prior to the end of the warranty period.
  - B. Return 90 to 120 days after the system has been turned over to the Owner for additional programming, maintenance and system fine-tuning. Conduct interviews with the user group via telephone to acquire information needed to complete this task. Allow for one full day of programming in your initial bid to complete. Provide a per hour programming fee that will be charged if additional programming is needed.
  - C. Cache for event logging must be set to record unlimited events until the Contractor's first maintenance site visit. After the Contractor's first maintenance site visit, the cache can be limited to the Owner specified level.
  - D. The Contractor shall use qualified service personnel to conduct all maintenance work.
  - E. All maintenance work shall be performed during regular working hours unless the Owner



agrees to pay the difference in labor rates for overtime or night time work.

- F. Items furnished to the Owner by the Contractor for future maintenance and repair:
  - 1. Provide one spare lamp for video projectors.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Quality of Products
  - 1. Materials and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the specified systems.
  - 2. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.
  - 3. Each material, device or piece of equipment provided herein shall comply with all of the manufacturer's published specifications for that item.
  - 4. Equipment shall be from the manufacturers' current stock and shall not be stored longer than 1 year prior to installation, unless written approval to do otherwise is provided by the manufacturer and submitted for review by the Owner.
  - 5. All products will be a product of firms regularly engaged in the manufacturing of electrical, electronic or optical equipment. The equipment will be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are prohibited and should not be submitted for review.
  - 6. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated, shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and will be verified by inspection. Only firms having 5 years of experience in all aspects of the fabrication and installation of similar systems will be allowed to perform the work.
  - 7. All materials and products will be new and of professional quality. Unless specifically stated in the drawings or specifications, no existing or used materials will be installed.
- B. Quantity
  - 1. Provide the quantity of products as shown on the Contract Drawings, or as otherwise indicated herein.
  - 2. The equipment listed in section 2.2 consists of all major equipment for the project. The Contractor will integrate into the system design and provide any additional components, wiring, programming, etc., to complete a functional system operating as described within the specifications and the category AV drawings.
  - 3. Components or equipment not specified or indicated on the drawings that are required to make a fully functional systems per the Owner's requirements and the design intent, shall be furnished and installed by the Contractor, and shall be submitted for Owner review.
- C. Preference
  - 1. Where more than one manufacturer is listed herein as acceptable or equivalent, no preference is intended or implied by the order of listing.
- D. In the event that a specified piece of equipment or product has been superceded, discontinued or is no longer available from the manufacturer, the Contractor shall submit a request for substitution of the originally specified product. The substitute product shall be the manufacturer's most current model of the specified product, or if the line has been discontinued, a product by the same manufacturer with specifications meeting or exceeding,

and as close as possible to those of the originally specified product. Refer to Alternatives and Substitutes section for clarification.

- E. Deferred purchase of equipment, including computers, touch panels, videoconferencing codecs, flat panel displays and video projectors with short market life expectancy
  1. Applies to the installation of equipment that is scheduled to take place more than 8 months after the bid has been awarded.
  2. Contractor shall, with his bid, breakout pricing for the above mentioned equipment and provide an allowance for these items.
  3. Ninety Days prior to its purchase, the Contractor shall submit for the Consultant's approval, a list of the equipment that has replaced or superseded the specified equipment.
  4. The submittal will include the manufacturer's specification sheets and other documentation to verify that the equipment meets the standards of the original specification.
  5. In the event that the Contractor's allowance for the equipment to be installed exceeds the current pricing, the price differential shall be returned to the Owner as a credit. The credit shall include the current price differential plus markups for overhead and profit and shall be documented in writing.
  6. In the event that the current pricing exceeds the allowance, the Contractor shall submit a detailed cost breakdown clearly indicating the current pricing differential and all markups requested.
- F. Provide Complete
  1. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.
- G. Provide New
  1. All materials provided under the Work of this Section shall be new, shall be the manufacturer's latest design/model, and shall be permanently labeled with the manufacturer's name, model number and serial number.
  2. Products and materials shall be clean, free of defects, damage and corrosion.
- H. Similar
  1. Similar devices shall be of the same manufacturer, unless specifically noted otherwise in these specifications.
- I. Safety Agency Listing
  1. All devices provided under the Work of this Section that are connected to the Project electrical system shall be listed by Underwriters Laboratories (UL) or other Nationally Recognized Electrical Testing Laboratory acceptable to the Authorities having jurisdiction at the Project site, and shall be so labeled. Absent such listing, comply with Regulatory Requirements applicable to Unlisted Equipment.
- J. Unlisted Equipment
  1. Certain equipment specified herein may not bear listing by a Nationally Recognized Testing Laboratory. Such equipment is specified herein only where no equipment is known to exist bearing such listing which that perform the function required by the Owner. In such case, apply for field inspection of such equipment. The Contractor is responsible for the payment of such inspection costs.
- K. Power Rating
  1. All devices provided under the Work of this Section that are connected to the Project electrical system shall provide stable performance in full accordance with these specifications when operated on main service which complies with ANSI standard tolerances for voltage, frequency, transients and related parameters.

- L. Circuit Protection
  - 1. All active devices shall have integral fuse or circuit breaker protection.
  - 2. All circuit breakers shall be fully magnetic.
  - 3. Protection devices shall be located to facilitate examination, resetting and/or replacement without the need to disassemble or demount the associated device.
  - 4. Contractor-fabricated items shall be provided with either indicating type circuit breakers or fuses of the clear glass cartridge type, mounted in fuse holders which will indicate a blown or defective fuse.
- M. Continuous Use
  - 1. All active circuitry shall be solid state and shall be rated for continuous use. All circuit components shall be operated in full compliance with the manufacturer's recommendations and shall contain sufficient permanent identification to facilitate replacement.
- N. Construction
  - 1. All electronic equipment shall be of the "dead-front" type and shall be designed for standard 19" EIA rack mounting, unless otherwise indicated.
  - 2. Steel frames and enclosures shall be designed and wired to eliminate all induced currents within both the units and the systems.
  - 3. All bolted connections shall be made with self-locking devices.
  - 4. Coordinate all consoles and panels so that the general appearance is similar, or as directed by the Owner.
  - 5. All operating panels shall be at least 1/8" thick aluminum.
  - 6. Provide locking panel covers on all recessed, semi-recessed or surface mounted control panels not located in the equipment rooms, unless specifically noted otherwise. Panel locks shall be flush with no protrusions beyond the panel face when the door is closed. Recessed control panels shall be recessed within the back box to a depth sufficient to permit a locking hinged panel cover to completely close without affecting any device within the enclosed area.
- O. Circuit Boards/Modules
  - 1. All printed circuit boards or modules shall be mechanically secured by bolt or friction-loading guide, in addition to any electrical connector attachment, and shall include an integral extraction grip.
  - 2. Printed circuit boards shall be connected to associated circuitry via soldered connections or precious metal positively keyed card edge connectors.
  - 3. All Contractor-fabricated printed circuit boards shall be at least 1/16" thick G-10 glass fabric epoxy base, copper plated to a minimum density of 2.0 oz./sq. ft. on one or both sides, and finished with 60/40 tin/lead solder either hot rolled or plated over the copper. All holes through the boards shall be plated through and solder filled. All boards shall be permanently identified with a designation that matches that of the mating connector or board position in the assembly.
- P. Identification
  - 1. Provide permanent intelligible identification on, or adjacent to, all connectors, receptacles, controls, fuses, circuit breakers, patching jacks, and the like. This identification shall clearly and distinctly indicate the function of the item and shall be numbered or lettered to correspond with the function, circuit and location consistent with field and shop drawings. Refer to section 3.5 for clarification.
- Q. Modular Products
  - 1. The drawings show conventionally packaged components to convey design intent.
  - 2. Card cages to have front and rear closure panels to provide a finished appearance.
  - 3. Except as noted below, modules of different functional types are permitted to share the

same card cage/mounting frame and/or power supplies as applicable and if mechanically and electrically compatible..

4. With amplifier input driven 10 dB beyond input level required to produce full rated output, amplifier shall withstand indefinitely any of the following load conditions without instability of operation of main over current protection (i.e. no blown fuses or circuit breakers).
  - a. "Short" circuit of 0.1 ohm.
  - b. Open circuit (no load).
  - c. Rated load impedance.
5. Maintain sense of signal polarity from input to output.

R. Keys

1. Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically. For each unique key type, provide a quantity of ten. Stamp each key with a reference designation.
2. Submit a schedule of keying to the Owner. Where so noted, provide Project Standard lock cylinders and keys; coordinate with the work of other Sections.

S. Lectern Power Cord

1. The power outlet connecting the lectern to the floor box must be twist-lock type. The power cord connecting the podium to the floor box must be 12 inches shorter than the low voltage cable connecting it. This will protect the low voltage cable from damage if the podium was to be moved inadvertently without disconnecting the cables. The power cable shall include a wire-rope strain relief to keep the power cord from damage. See cable detail on plan-set for more information.

T. Assistive Listening System (RF)

1. An assistive listening system using wireless radio frequency (RF) transmitter and headsets will allow personal monitoring of the audio program for the hearing impaired. The transmitter will be a frequency agile unit with no less than 30-channel capability and will broadcast the main audio program to personal headsets used by hearing impaired audience members. The system and quantity of headsets supplied shall conform to the ADA requirements (section 219 and 706) for the space. Stereo headset type and hearing aid compatible (T-Coil) listening devices are required; ear-bud type devices are not acceptable. Supply a drop-in type battery charging system capable of servicing multiple receivers, with sufficient charging capacity to charge each receiver simultaneously. Follow the table below for quantity requirements.

Capacity of Seating in Assembly Area	Minimum Number of Required Receivers	Minimum Number of Required Hearing Aid Compatible Receivers
50 or Less	2	2
51 to 200	2, plus 1 per 25 seats over 50 Seats	2
201 to 500	2, plus 1 per 25 seats over 50 Seats	1 per 4 Receivers
501 to 1000	20, plus 1 per 33 seats over 500	1 per 4 Receivers
1001 to 2000	35, plus 1 per 50 seats over 1000 seats	1 per 4 Receivers
2001 and over	55, plus 1 per 100 seats over 2000 seats	1 per 4 Receivers

U. Projection Screens

1. Provide extra screen material drop to locate the projection screen at the optimum viewing angle where required. Verify screen drop requirements with architectural sections and elevations.

- V. Provide enclosure systems including, but not limited to racks, cabinets, cases and related panels and accessories as specified herein, or approved equivalent. Provide size and quantity as shown on drawings. Provide color as specified by Architect. If no color is shown on drawings, submit manufacturer's standard color chips for selection.
- W. Cable Tray: Provide aluminum ladder style cable tray with flange in side rails where called out in drawings. Size the cable tray to accommodate all wire that must pass through it. Provide all supporting hardware and accessories.
  - 1. Ladder Style Cable Tray
    - a. P-W Industries.
    - b. Equal by Hubbell.
    - c. Approved equal.
- X. Floor Mounted Equipment Racks: Provide each bay with basic frame, vented locking rear door, top panel with single 10" fan, certified seismic floor anchor kit, ganging hardware, except where otherwise indicated, at each ensemble of bays, provide end (side) panels to provide complete enclosure.
  - 1. Rack cabinet, heavy duty welded 14ga. CRS, single bay of maximum dimensions 83-1/8"(H) x 24"(W) x 32.5"(D); floor supported with accessory louvered side rack side panel.
    - a. Mid Atlantic WRK Series.
    - b. Equal by Atlas/Soundolier.
    - c. Approved equal.
  - 2. Turret cabinet:
    - a. Mid Atlantic Slim 2 Series.
    - b. Equal by Atlas/Soundolier.
    - c. Equal by Hammond Manufacturing.
  - 3. Wall cabinet, tilt out:
    - a. Atlas/Soundolier AWR Series.
    - b. Mid Atlantic WRS Series.
    - c. Equal by House of Metal Enclosures (HOME).
    - d. Equal by Hammond Manufacturing.
  - 4. Wall Mounted cabinet:
    - a. Atlas/Soundolier 300 Series.
    - b. Mid Atlantic DWR Series.
    - c. Equal by Hammond Manufacturing.
  - 5. Floor mounted pivoting rack:
    - a. Mid Atlantic SR-40-22 Swing Rack.
    - b. Equal by Atlas/Soundolier.
- Y. Rack Panels and Accessories: Rack Mounting Screws: Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.
  - 1. Blank Panels:
    - a. Atlas/Soundolier S19 Series.
    - b. Zero ZP112000 Series.
    - c. House of Metal Enclosures (HOME) Series PM.
    - d. Middle Atlantic Products BL, SB or HBL Series.
  - 2. Vent Panels:
    - a. Middle Atlantic ETF Series.
    - b. Equal by Atlas/Soundolier.
    - c. Equal by Zero.
    - d. Equal by House of Metal Enclosures (HOME).
  - 3. Shelf:
    - a. Middle Atlantic Products U Series.

- b. Atlas/Soundolier SH19 Series.
    - c. Zero A52 Series.
  - 4. Drawer:
    - a. Atlas/Soundolier SD Series.
    - b. Middle Atlantic Products UD Series.
    - c. House of Metal Enclosures (HOME) SD Series.
    - d. Zero A43/A36 Series.
  - 5. Cassette Holder: Middle Atlantic Products Model RSH-4A.
  - 6. Compact Disc Holder: Middle Atlantic Products Model RSH-4A.
  - 7. VCR Holder: Middle Atlantic Products Model RSH-4A.
  - 8. LP/Laser Disc/Binder Holder: Middle Atlantic Products Model LP.
  - 9. Rackmount Computer Keyboard: Middle Atlantic RM-KB.
  - 10. Equipment Custom Rackmount Shelf: Middle Atlantic Products Model RSH-4A Series.
  - 11. Rackmount Computer Keyboard.
    - a. Mid Atlantic RM-KB series.
    - b. Approved equal.
  - 12. Computer Monitor Rackmount.
    - a. Mid Atlantic RM-MM series.
    - b. Approved equal.
  - 13. Horizontal Lacer Bars
    - a. Mid Atlantic LBP-IR4, LBP-1S, LBP-1P.
    - b. Equal by Atlas/Soundolier.
- Z. Equipment Enclosure Ventilation: Provide UL Recognized devices. Connect to enclosure power, comply with applicable Codes.
- 1. Fan panel, 5 1/4" high painted steel rack panel with 4" diameter fans, each fan with chrome plated finger guard, low speed air flow, two fans per panel, total 120 CFM:
    - a. Mid Atlantic QFP-2 Series.
    - b. Atlas/Soundolier ES/IS Series.
    - c. BGW Systems.
  - 2. Thermostatic Fan control module, user definable temperature range with status LED's, temperature sensing probe.
    - a. Middle Atlantic FC Series.
    - b. Atlas/Soundolier CFT Series.
- AA. Equipment Enclosure Power and Signal Grounding: Comply with applicable Codes and applicable portions of Division 26. Provide UL Listed devices, Specification or Hospital Grade. Provide all junction boxes, raceway, fittings, wire, supports and fastenings as required for complete installation. Unless otherwise noted, provide receptacles of NEMA 5-15R configuration.
- 1. Full height receptacle strip, Isolated Ground:
    - a. Wiremold 3000 Plugmold IG Series.
    - b. Middle Atlantic PD series vertical power strips.
  - 2. Full height receptacle strip, three or more circuits, Isolated Ground:
    - a. Wiremold 3000 Series with Specification Grade IG 5262 Series receptacles.
    - b. Middle Atlantic PD series vertical power strip.
  - 3. Wireway, lay in, NEMA 1: Any meeting NEMA 1 and UL870. Size as required.
  - 4. Flexible metal conduit: Comply with Division 26.
  - 5. Sequencing Power System:
    - a. The Contractor is to design and build power sequencing and surge suppression systems that will control and distribute power in the equipment racks. The system will be designed to sequentially connect power to all of the audio-visual equipment in the equipment racks. Outlets are mounted to the unit's back plate or on a remote strip. If the project utilizes a control system, the sequencing power system will be controlled by the software configurable control system. The touch panel's shut down button will prompt a second time asking "Are you sure

you want to shut the system down?" A positive response will activate system shut down. A push button control station's shut down button will be pressed twice to shut down the system. If the project does not include a control system, the Contractor is to provide a dedicated sequential controller in the equipment racks.

- 1) 15 amp or greater power capacity.
- 2) 3-prong 15 amp 120VAC isolated ground outlets (provide required amount).
- 3) Individual sequencing steps for each outlet.
- 4) Adjustable power-up time delay and outlet sequencing intervals.
- 5) Modular power raceway systems shall be constructed of 18-gauge min-spangle galvanized steel.
- 6) Remote controllable via contact closures (if applicable).
- 7) Status indicator on touch panel (if applicable).
- b. Approved subject to above:
  - 1) Middle Atlantic RLM-XX, RM-XX, R-XX or M-XX Modular Power Raceway Series.
  - 2) Middle Atlantic USC-6R Universal Sequencing Controller.
  - 3) Equal by Atlas Soundolier.
6. Signal Grounding bus bar, insulated from enclosure frame:
  - a. Atlas/Soundolier BBG Series mounted on standoff insulators.
  - b. Zero A32 Series.
  - c. Middle Atlantic.
  - d. Panelboard Isolated Ground bus kit by manufacturer of Project Panelboards specified in Division 26.
7. Multi-Outlet Assembly, Surge Suppressing, UL Listed. Comply with ANSI/IEEE C62.41-1980. Provide at least six receptacles. Provide equivalent to:
  - a. Surgex SX RT series.
  - b. EFI Electronics Corporation Model 153.
  - c. MCG Electronics, Inc. Model 296 (subject to UL Listing).
8. Computer Grade Uninterruptible Power System, UL Listed. Provide continuous, no-break power with sine wave output. Provide Transient Over-Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B. Provide complete isolation from Line. Provide output voltage regulation to ANSI C84.1 for computing equipment. Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated. Provide one for each Central Processing Unit, Digital Signal Processor and automated control console. Provide equivalent to:
  - a. Best Power Technology, Inc. "Micro-Ferrups" Series.
  - b. Best Power Technology, Inc. "Axxium" Series.

BB. Audio Patching and Related:

1. Audio Patching Jack Assemblies; jackfield two times forty-eight (2x48) jacks: Factory pre-wired to insulation displacement connection system, normals brought out to connection system, connection system on backplane of jackfield chassis or a separate unit on cable harness, 2 row by two times forty-eight (2x48) jack array of Bantam Plugs:
  - a. ADC Pro Patch Mark IV (Bantam).
  - b. Bittree Audio TT (Bantam).
  - c. Switchcraft TTP96FA (Bantam).
2. Audio Patching Jack Assemblies; jackfield 48 jacks: Factory pre-wired to insulation displacement connection system, normals brought out to connection system, connection system on backplane of jackfield chassis or a separate unit on cable harness, 2 row by 24 jack array of 1/4" tip-ring-sleeve Longframe pattern jacks:
  - a. ADC Pro Patch Mark IV Long Frame.
  - b. Bittree Audio Long Frame 1/4".
3. Audio Patching Cords: Manufactured to match mechanically, electrically and materials with audio patching jack assemblies specified herein. Flexible shielded cable, length

as required. Provide with non-corroding metal. Provide equivalent to:

- a. ADC Pro Patch ¼" Long Frame Patch Cords.
  - b. ADC Pro Patch Bantam.
  - c. Bittree ¼" Long Frame Patch Cords.
  - d. Bittree Audio TT (Bantam) Patch Cords.
  - e. Provide Quantity:
    - 1) Two foot: Eight for each 2x24 Audio Jackfield.
    - 2) Two foot: Sixteen for each 2x48 Audio Jackfield.
4. Audio Patching Cords, Adapter: Manufactured to match mechanically, electrically and materials with audio patching jack assemblies specified herein. Flexible shielded cable, length six feet. Provide with non-corroding metal 1/4" tip-ring-sleeve longframe pattern plug one end equivalent to Neutrik. Provide opposite end, Circular Audio Connector, Cord, as specified herein. Provide equivalent to:
- a. Patch to Male:
    - 1) Audio-Line 310 Series.
    - 2) Pro Co Sound C-PJ/MXB-B-6-P2H.
  - b. Patch to Female:
    - 1) Audio-Line 310 Series.
    - 2) Pro Co Sound C-PJ/FXB-B-6-P2H.
  - c. Provide Quantity:
    - 1) Patch to Male: Provide 12.
    - 2) Patch to Female: Provide 12.
5. Patching Cord Holders: Provide adjacent to each jackfield. Provide quantity as required to store patching cords specified herein:
- a. Audio Accessories Maxi Holder.
  - b. Trompeter Electronics Model CH-50.
  - c. Pomona Electronics 4408.

CC. Video Patching and Related:

1. Video Patching Jack Assemblies; jackfield (2x32) isolated jacks: 75 Ohm digital and analog capable, ( 2x32) jack array, 3GHz bandwidth, SMPTE 259M and 292M compliant:
  - a. Canare (MD-Series)
  - b. Bittree (Mini-WECO)
  - c. ADC (PV-Series)
2. Video Patching Cords: Manufactured to match mechanically and electrically with video patching jack assemblies specified herein. Flexible shielded cable, length as required. Provide with non-corroding metal. Provide equivalent to:
  - a. Canare (Mid-size Video Patch Cord)
  - b. Bittree (Mini-WECO Patch Cord)
  - c. ADC (ST series Patch Cord)
  - d. Provide Quantity:
    - 1) Two foot: twelve for each 2x32 Video Jackfield.

DD. Data Patching and Related:

1. Data Patching Jack Assemblies; jackfield two times twenty four (2x24) jacks. Meet or exceed Category 6 requirements described in TIA/EIA-568-C.2-1 as well as the Class E requirements described in ISO/IEC 11801-B.:
  - a. Leviton eXtreme 6+ Quickport Patch Panel (or equal).
2. Provide patch cords for patch points as required.



## 2.2 PRODUCTS

### A. Major System Components

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DEVICE ID	DESCRIPTION	MANUFACTURER	MODEL	ACCESSORIES
ALA	ASSISTIVE LISTENING ANTENNA	LISTEN	LA-122	
ALR	ASSISTIVE LISTENING RECEIVER	LISTEN TECH	LR-400	
ALT	ASSISTIVE LISTENING TRANSMITTER	LISTEN TECH	LT-800-216	
BP1	BELTPACK	SHURE	ULX1	
CCB	CABLE CUBBY	EXTRON	CABLE CUBBY 200	
DVD	DVD PLAYER	PANASONIC	DMP-BD70V	
ERK1	EQUIPMENT RACK	MIDDLE ATLANTIC	DWR-21-22	
LEC	LECTERN	FORBES AV	8524	LOCKING CASTERS, GOOSENECK LIGHT, DOCUMENT CAMERA TRAY.
M1	MICROPHONE INPUT	FSR	T3-MJ	
MIC1	MICROPHONE	COUNTRYMAN	ISOMAX 4	
MIC2	MICROPHONE	SHURE	WL183	
NWS1	NETWORK SWITCH	CISCO	3560C-8PC-S	
PA1	POWER AMPLIFIER	QSC	CX302	
PA120	POWER AMPLIFIER	TOA	BG-2120	
PJS	PROJECTION SCREEN	DRAPER	SILHOUETTE/SERIES V	TAB TENSIONED, HI-DEF GREY SCREEN MATERIAL
SC1	CEILING SPEAKER	QSC	AD-CI52ST	
SIW1	IN-WALL SPEAKER	TANNOY	iw62 TDC	BACK CAN
SIW2	IN-WALL SPEAKER	TANNOY	iw4 DC	BACK CAN W/ TRANSFORMER
SYSW	SYSTEM SWITCHER	CRESTRON	DMPS-300-C	
TAM	TELEPHONE ACCESS MODULE	BOGEN	TAMB2	
TCR1	TRANSCODER	CRESTRON	DM-TX-200-C-2G	
TCR2	TRANSCODER	CRESTRON	DM-RMC-100-C	
TPC1	TOUCH PANEL CONTROL	CRESTRON	TPMC-8X-GA	DOCKING STATION TPMC-8X-DSW
VPJ1	VIDEO PROJECTOR	NEC	NP-PA500U	NEC NP14ZL LENS, PEERLESS PWA-14 WALL MOUNT, EXT### EXTENSION POLE AND PAG-UNV-MU PROJECTOR MOUNT
WAP	WIRELESS ACCESS POINT	CRESTRON	CEN-WAP-ABG-1G	
WMAA	WIRELESS MIC ANTENNA AMP	SHURE	UA830WB	
WMR	WIRELESS MIC RECEIVER	SHURE	ULXP4	


[illegible]

B. The above list of Major System Components only outlines the major items necessary to allow

the system to function as designed. It lists no power supplies, balancing transformers, power splitters, modular cards or other auxiliary components required to achieve a functioning system. Contractor is required to supply all components needed to provide a complete and operable system as outlined in the contract documents. The full set of construction documents are to be used when preparing a bid. This list is not intended to provide a full bill of materials.

## 2.3 FINISHES

- A. Any item or component of the Work of this Section which is visible shall comply with the following. Finishes noted or scheduled on the Contract Drawings shall take precedence. Submit all color samples of all items visible to public for approval.
  - 1. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Owner.
  - 2. Paint loudspeaker cabinets to match exactly the surrounding and adjacent surfaces. Submit paint sample to Owner's representative for approval.
  - 3. Unless otherwise noted, receptacle or device plates subject to connection or operating force shall be stainless steel or hard anodized aluminum. Provide plates which generally match the appearance of project standard receptacle or device plates in view in the same area. For anodized aluminum, submit samples of standard colors for selection by Owner.
  - 4. Operating panels shall be steel, primed, painted with thermosetting epoxy paint, with legends silk-screened in contrasting color, and coated with clear epoxy thermosetting coating; or aluminum, hard anodized, with legends engraved and filled with contrasting color, all coated with clear epoxy thermosetting coating.
  - 5. All steel surfaces shall be treated with primer equivalent to zinc phosphate and finish painted with baked enamel or painted with a thermo setting epoxy paint.
  - 6. All aluminum surfaces, except those used as operating surfaces, shall be anodized and then painted with a thermo setting epoxy paint.
- B. Custom Fabricated Plate Screws
  - 1. Match the finish of the screws used to mount the custom fabricated plates with the finish of the custom fabricated plate.
- C. Ceiling Loudspeaker Grilles
  - 1. Paint loudspeaker grilles to match exactly the surrounding and adjacent surfaces (when speakers are recessed). Apply paint to permit servicing of loudspeakers without damage to finish of adjacent or adjoining surfaces. Provide uniform appearance. Do not obstruct grille openings with paint. Submit paint sample to Owner's representative for approval.
- D. Manufacturer's logos
  - 1. Remove all manufacturers' names, logos, or other symbols from speakers or other objects placed in view of the public.

## 2.4 ALTERNATIVES AND SUBSTITUTES

- A. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If a requested substitution requires a change in any of the contract drawings, a revised drawing must be submitted as part of the substitution request. The Owner's Representative will be the final judge of the acceptability of substitutions. The burden of proof of equivalence is the responsibility of the Contractor.
- B. Acceptance of a product shall not, in any form or manner, relax the system performance requirements of this Specification and the performance characteristics of the product.
- C. The Contractor shall submit for review a complete list of proposed substitutions for approved

equipment listed in Part 2.

- D. For all substitutions, the Contractor shall provide the manufacturer's independent test data to demonstrate that the proposed alternatives to the approved equipment comply with the specifications. Specifications shall contain at least all information available for the specified product.
- E. The Contractor shall submit a description and drawings showing all changes to the Contract Documents that the proposed substitution will require for proper functionality and operation.
- F. Proposed substitutions shall not affect dimensions shown on the Contract Document except as submitted for review and approved by the Owner.
- G. Any redesign or construction costs required to integrate the proposed substitution shall be the responsibility of the Contractor. Any costs incurred by the Owner, Owner's representatives, Architect, Engineers or Consultants attributable to the integration of a proposed substitution shall be borne by the Contractor.
- H. Any proposed substitution shall have no adverse affect on other trades, the construction schedule or specified warranty requirements.
- I. The functionality, performance, general appearance and quality of the proposed substitution are equivalent to or superior to those of the specified item.
- J. Any change to the Contract (deductive or additive cost) associated with a proposed substitution shall be submitted to the Owner for review at the time the substitution is proposed and accompanying a substitution request documentation.
- K. The Contractor will provide the same warranty for the substitution that the Contractor would for the specified product.
- L. The Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects equal to the designed system before the substitution was made. In the event that the substituted material or equipment fails to meet performance testing standards after installed, the Contractor will replace substituted material or equipment with those initially specified.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Furnish and install (herein, "provide") all materials, devices, components, and equipment required for complete, operational systems.
- C. Contractor is to supervise the installation of back boxes and terminal cabinets installed by the Division 26 Contractor. Contractor is to verify that correct boxes are installed in their proper locations before any drywall has been installed.

#### 3.2 EXAMINATION

- A. Immediately report to the Consultant any discrepancies between the specifications and drawings. This includes discrepancies between the technical specification documents and

actual field dimensions or findings that may hinder installation work, conflict with other trades, or cause delays.

- B. Carefully examine all details that affect all aspects of the systems described in the specifications and drawings.
  - 1. Examine, coordinate and confirm all drawings and details.
  - 2. Examine, coordinate and confirm all electrical power requirements, conduits, raceways, boxes, and etc.
  - 3. Examine, coordinate and confirm work of other trades that may influence the outcome of the design, specification, and performance of the systems.

### 3.3 PREPARATION

- A. This installation section is only meant as a guideline for the Contractor. The Contractor shall be responsible for executing all installation work in a manner that is in accordance to industry-accepted standards or governing codes, whichever is more stringent. Installation activities shall be executed in an organized and orderly manner. These steps include, but are not limited to, pre-delivery testing, delivery, unloading, installation, equipment / cable labeling, programming, set-up / calibration / alignment / adjustment, testing, commissioning, training, and documentation.
- B. Protect all existing work surfaces, furniture, equipment, fixtures and etc. before commencing installation work. Any damage to the existing physical and electrical property due to installation work shall be the responsibility of the Contractor.
- C. Immediately hand over any de-installed equipment to the Owner for disposal or safe-keeping.
- D. Carefully remove any obstructions such as fixed seating, ceiling tiles, furniture, equipment and etc. that would obstruct or hinder the installation work. Damage caused by undue care in moving these items shall be responsibility of the Contractor.
- E. Examine, coordinate, and confirm the cleanliness of the work site before commencing the portion the installation work that involves dust-sensitive electronic or electrical equipment such as audio mixers, switchers, projectors, control processors, computers, cameras, etc. Dust-sensitive equipment that is installed in a work site with a lot of air borne dust and dirt shall be properly protected. For example, a video camera on a wall-mounted bracket is protected by a clean plastic bag to prevent dust from contaminating it. Seal the bag's opening using adhesive tape.
- F. Prior to commencing installation work, ensure that the surrounding areas are clean and promote ease of installation work.
- G. Ensure that all equipment rack and equipment locations are clean before commencing installation work.
- H. Unless specified otherwise, furnished products / equipment shall be tested, delivered and installed. And, all systems shall be tested and commissioned to fully operational and properly configured condition.
- I. All electrical equipment shall be burned-in or tested at the Contractor's shop before delivery. This pre-installation test shall reveal any equipment that is faulty, malfunctioning or dead out of the box ahead of time.
- J. All radio frequency (RF) operated devices shall be tested on-site prior to installation to determine blind spots, RF interference, or any other transmission / reception problems. The Contractor shall be responsible for costs associated with providing additional support or

accessory equipment (antennas, amplifiers, cables, etc.) and / or services to improve signal transmission / reception.

- K. Provide all support equipment (ladders, man-lifts, tools, etc.) required to complete the installation work in a safe and expeditious manner.
- L. Obtain any plan approvals, permits and licenses required by inspection authorities prior to execution of any installation work. The Contractor shall be responsible for all associated fees and costs incurred while fulfilling this requirement.
- M. Ensure that all equipment is accessible for operation and maintenance work. Under no circumstance shall equipment be inaccessible or inconveniently located.
- N. Aside from the systems' operational features, provide equal attention to the overall aesthetics of the installed equipment and cabling. Special attention to aesthetics shall be extended to equipment or cabling in public spaces.
- O. Firmly secure all fixed equipment and hardware in place and ensure that they are plumb and / or square. An exception to this shall be portable or movable equipment.
- P. Structurally mounted equipment: All equipment shall be mounted in accordance to all applicable safety codes, standards and practices. The one that provides for the most stringent rule shall prevail. All mounting hardware shall have a load rating by, at least, a factor of 5 (500% or greater) in reference to the weight of the equipment to be mounted or suspended. An exception to the rule shall be existing local safety codes or standards requiring greater load capacities.
- Q. Seismic restraints: Abide by all the seismic restraint requirements described in all applicable building codes in force at the work site. If no provisions exist for a particular situation, follow these minimal recommendations.
  - 1. Fixed equipment: Mount and brace to the building structure to minimize potential hazards to personnel and damage to property during any kind of seismic event.
  - 2. Floor mounted equipment: Bolt equipment securely to the floor to prevent from toppling during any kind of seismic event
  - 3. Vertical-mounted columns: Apply braces to the vertical column in four opposing directions back to the mounting surface. This will minimize sway in any direction. Provide a separate, flexible restraint (e.g. aluminum braided aircraft cable) with a capacity of 5 times the weight of the total mounting system. The same applies to the anchor to which the flexible restraint is attached and the method of attachment to the structure.
  - 4. No equipment, equipment supports, or mounts must fail before the structure fails.
  - 5. Seismic restraint measure must not interfere with fire stopping.
  - 6. Notwithstanding compliance with these minimum recommendations, it is the Contractor's responsibility to ensure that the seismic restraint measures taken are adequate for the circumstances, including, if required, verification by an independent structural engineer. The cost of all such engineering shall be the responsibility of the Contractor.
  - 7. Penetration of the Slab: Verify that any mounting or restraint work that requires deep or thorough penetration of the slab shall not damage embedded materials including, but not limited to, slab tensioning devices or conduit. Verify the slab by X-ray or other method before proceeding. The Contractor shall be responsible for all costs associated with this investigation.

### 3.4 INSTALLATION

- A. Follow manufacturer's instructions for installing, operating, configuring, and programming their

equipment. Do not perform modifications to equipment that would void its warranty.

- B. Pull and terminate all cables, and interconnect all equipment and components in accordance with approved drawings. Install audio-visual cover plates and faceplates onto all boxes.
- C. Loudspeaker Assembly Installation
  - 1. Loudspeakers:
    - a. Verify proper installation of loudspeaker enclosures and related support.
    - b. Verify that no loudspeaker assembly is subjected to stresses or loading effects in any way contributing to possible extraordinary failure.
    - c. Connect loudspeaker assemblies to the appropriate 70 volt-line transformer tap as applies. Verify specified polarity. Use insulated crimp connectors or insulated "bobtail" splices applied with manufacturer's recommended ratchet tooling. Wago Wall-Nuts 773 Series or equal are acceptable. Wire nuts or "Scotchlock" connectors shall not be acceptable.
    - d. Verify that loudspeaker grille openings and loudspeaker components are clear of paint after finishing.
    - e. Perform preliminary loudspeaker tests specified herein. Correct non-conforming conditions.
    - f. Adjust 70 volt-line transformer taps as required to realize uniform sound pressure level as specified herein. Document final 70 volt-line transformer taps on the Record Drawings.
    - g. Correct all conditions giving rise to noise, rattle or other extraneous sounds owing to operation of a loudspeaker assembly under any specified operating condition.
  - 2. Packaged Loudspeakers:
    - a. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of packaged loudspeakers. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Submit in timely manner.
      - 1) Comply with applicable Code and the requirements of the Authorities having jurisdiction.
      - 2) Provide safety factor greater than six or as required by Code, whichever is greater.
    - b. Mounting shall:
      - 1) Permit each packaged loudspeaker to be re-oriented at least plus or minus 5° from angles shown on the Contract Drawings for optimum coverage.
      - 2) Maintain precise location and orientation of each packaged loudspeaker component after such adjustment when subject to vibration of loudspeaker components due to operation at full specified system output level, and when subject to normal building motion and Code defined seismic induced building motion.
      - 3) Use rigid metal support members, such as threaded rod with locking nuts.
    - c. Test each packaged loudspeaker prior to installation at design locations. Test at least polarity and freedom from buzzes, rattles and objectionable distortion, using procedures specified herein. Correct non-conforming conditions.
    - d. Do not apply any load to building structure without first obtaining written approval of the Owner. Obtain per Project procedures.
    - e. During Acceptance Testing, adjust orientation of packaged loudspeakers as directed to achieve optimum coverage. Provide workers and ladders as required. Perform such adjustment with no claim for additional cost or time.
    - f. Do not suspend or orient the loudspeaker cluster prior to verification by the Owner or Owner's representative, that the intended location is correct with respect to as-built conditions such as the final dimensions of the space.



- D. Video Projectors
  - 1. Projectors shall be centered laterally to the projection screens.
  - 2. Projectors shall be mounted such that digital keystone compensation shall not be required.
  - 3. Selected projectors shall have lamp replacement and filter cleaning doors located in such a way that these items may be serviced while the projector is installed.
  - 4. Projectors shall be mounted such that their optical zoom settings shall not be set at either their widest nor narrowest extreme, but shall be used in their mid-range.

### 3.5 LABELING AND IDENTIFICATION

- A. All cables and connecting blocks shall be clearly, logically and permanently marked and identified by the following means:
  - 1. Use cable labels similar to the Panduit Polyolefin Self-laminating Labels for inkjet or laserjet printers or any other means acceptable to the Consultant. Cable labels should be machine printed and not handwritten.
  - 2. Cable labels should be placed approximately 12 cm. from each end of the cable.
  - 3. Labeling conventions shall be clear, logical, and must be acceptable to the Consultant.
  - 4. Include all cable identification numbers on all wiring diagrams and cable schedules.
  - 5. For fiber optic cables, use cable identification products such as the Panduit Labelcore series or any other means acceptable to the Consultant.
  - 6. For connector and terminal blocks, label using any means acceptable to the Consultant.
- B. All cover plate, switches, panels, outlets, etc. labeling shall be engraved and filled, or silk-screened or by any other means acceptable to the Consultant. Do not use Dymo, Brother, or other similar labeling products.
- C. Protective Devices
  - 1. Identification of fuses and circuit breakers shall indicate protected circuitry, rating of protective device and voltage across open circuited protected device.
- D. Panels and Receptacles
  - 1. Panel surfaces shall be engraved and filled or silk screened with identification, or shall be provided with 1/16 inch (minimum) thick laminated plastic labels with engraved block characters at least 1/8 inch high fastened to the equipment by stainless steel screws or rivets. Provide white characters on black background unless otherwise noted. Embossed plastic (Dymo) labels shall not be acceptable.
- E. All equipment shall be labeled in a clear, logical manner or by any other means acceptable to the Consultant.
  - 1. For Control Knobs and Sliders: Use 6mm (1/4") round labels, such as the Avery 057xx series, to indicate level settings. Neatly draw an arrow on the label using a fine tip permanent marker to accurately indicate the position of the control knob. If a control knob or slider has multiple level settings, use a logical and consistent color scheme to identify each setting. Illustrate all equipment settings in the Operation Manual.
  - 2. For equipment identification, use 'badges' made of aluminum or plastic or any other acceptable material with engraved and filled, or silk-screened labeling. Stick these badges using industrial-strength doubled-sided 3M adhesive tape. Note: Labels made using Brother-type label maker or similar machines can be used as long as industrial-strength double-sided tape is used to hold the label in place. Label schemes should be clear, logical, and simple or by any other means acceptable to the Consultant. Indicate equipment labeling schemes on all elevation and plan drawings showing the front and / or rear of the equipment racks. The reader should be able to easily reference the label description to specific equipment in the Operation and / or Maintenance Manuals.

### 3.6 WIRING

- A. General
  - 1. This section does not apply if the drawings incorporate a wire schedule.
- B. Audio Signal Wiring Classification:
  - 1. Type A-1: Microphone level wiring less than -30 dBu, 20 Hz to 20 kHz.
  - 2. Type A-2: Line level wiring -30 dBu to +24 dBu, 20 Hz to 20 kHz.
  - 3. Type A-3: Loudspeaker level or circuit wiring greater than +24 dBu, from 20 Hz to 20 kHz.
- C. Video/Graphics and Related Signal Wiring Classification:
  - 1. Type V-1: Baseband and composite video wiring 1 volt peak-to-peak into 75 ohms, 0 to 100.0 MHz.
  - 2. Type V-2: Synchronization and switching pulse wiring 4 volts peak-to-peak into 75 ohms, 15.62 to 15.75 kHz.
  - 3. Type V-3: Color subcarrier wiring 0 to 4 volts peak-to-peak into 75 ohms, 3.57 to 4.43 MHz.
- D. Control Signal Wiring Classifications:
  - 1. Type C-1: DC control wiring 0 to 50 volts.
  - 2. Type C-2: Synchronous control or data wiring 0 to 40 volts, peak-to-peak.
  - 3. Type C-3: AC control wiring 0 to 48 volts, 60 Hz.
- E. Additional Wiring Classifications:
  - 1. Type M-1: DC power wiring 0 to 48 volts.
  - 2. Type M-2: AC power wiring greater than 50 volts, 60 Hz.
- F. Wiring Combinations: Except as indicated herein, conduit, wire ways and cable bundles shall contain only wiring of a single classification. The following combinations are acceptable in conduit, or cable harnesses. Additional acceptable combinations may be indicated on the Contract Drawings.
  - 1. Types A-1, C-1, and M-1.
  - 2. Types A-2, C-1, C-2, and M-1, runs less than 20 feet.
  - 3. Types A-2, C-1, and M-1.
  - 4. Types A-3, C-1, C-2, and M-1.
  - 5. Types A-2, V-1, and V-3.
  - 6. Types V-1, V-2, V-3, and C-1.
  - 7. Types M-2 and C-3.

### 3.7 WIRE AND CABLE INSTALLATION

- A. Provide permanent identification of run destination at all raceway terminations.
- B. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.
- C. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels, connector shell or equipment enclosures.
- D. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards. Outside buildings, make splices only in designated manholes and/or hand holes. Protect splices outside of buildings with splicing kits equivalent to Scotch-cast Re-enterable. Make splices only with connectors or terminal devices specified herein. Document all splices on Record Drawings.

- E. Verify that all raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.
- F. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.
- G. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.
- H. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Provide tool formed thermal expansion loops at cable at manholes, handholes and at both sides of all fixed mounted equipment. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.
- I. Secure all wire and cable run vertically for continuous distances greater than 30 feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar approved devices appropriate to weight of cable. For all other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.
- J. All Category type cable, connectors and plugs shall be color coded for easy visual distinction. Color coded insert type boots shall be installed on all Category type plugs. A colored coded ring will be provided on all chassis connectors (i.e. Neutrik ACRF-#). Cable connectors shall be equipped with Neutrik BSE-# color coded bushings. The Color code shall be as follows:
  - 1. Digital Video / AV UTP =Green
  - 2. LAN =Yellow
  - 3. AV Local Area Network =Orange
  - 4. Quick Media =Blue
  - 5. AV UTP =White

### 3.8 CONNECTOR AND SIGNAL POLARITY CONVENTION

- A. Maintain consistent absolute signal polarity at all connectors, patch points and connection points accessible in the system. Where applicable, a positive polarity electrical signal shall yield positive acoustic pressure from the loudspeakers.
- B. Audio signal connector convention: AES14-1992 (ANSI S4.48-1992) AES standard for professional audio equipment - Application of connectors, Part 1, XLR-type polarity and gender.

<u>Signal</u>	<u>Connector</u>	<u>Wire</u>
Signal Phase	Pin 2	Red or White
Signal Anti-Phase	Pin 3	Black
Signal Ground	Pin 1	Drain Wire

- C. Video and RF/MATV Connector Convention:

<u>Signal</u>	<u>Connector</u>	<u>Wire</u>
Signal Phase	Center Pin	Center conductor
Signal Anti-Phase	Shell	Shield
Signal Ground	Shell	Shield

- D. Voice/Data Connector Convention: Comply with EIA/TIA-568C.

### 3.9 WIRING PRACTICE

- A. Land all non-coaxial field wiring entering each equipment rack at specified terminal devices prior to connection to any equipment or devices within racks. At Contractor's option, such terminals may be located in the equipment racks or at backboards provided. Coordinate such selection with Project construction sequence and test procedures specified herein.
- B. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one inch of each connection. Indicate the number designated on the associated field or shop drawing or run sheet, as applies. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Provide any of the following:
1. Continuous permanent imprint; equivalent to Clifford of Vermont, Inc. "Quik-Pull".
  2. Direct hot stamp.
  3. Heat shrinkable factory hot stamped; equivalent to Brady sleeve Heat shrink.
  4. Adhesive strip printed labels wrapped the full circumference of the wire and sealed with clear heat shrink tubing; equivalent to Thomas and Betts or Panduit Insta-code with clear heat-shrunk tubing equivalent to Alpha.
- C. Apply all crimp connectors only with manufacturer's recommended ratchet type tooling and correct crimp dies for connector and wire size. Plier type crimp tooling shall not be acceptable.
- D. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.
- E. Make all connections to screw-type barrier blocks with insulated crimp-type spade lugs. Lugs are not required at captive compression terminal type blocks. Provide permanent designation strips designed for use with the terminal blocks provided. Make neat, intelligible markings with indelible markers equivalent to "Sharpie".
- F. Tin terminated shield drain wires and insulate with heat shrinkable tubing.
- G. Use only rosin core 60/40 tin/lead solder for all solder connections.
- H. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.
- I. Termination and build out resistors and related circuit correction components shall be visible. Do not install in connector shells or internally modify equipment. Show locations on Record Drawings.
- J. Correct any and all of the following unacceptable wiring conditions:
1. Deformed, brittle or cracked insulation.
  2. Insulation shrunken or stripped further than 1/8-inch away from the actual point of connection within a connector, or on a punch block.
  3. Cold solder joints.
  4. Flux joints.
  5. Solder splatter.
  6. Non-grommet, non-bushed, or non-insulated wire or cable entries.

7. Deformation or improper radius of wire or cable

3.10 SIGNAL GROUNDING PROCEDURES

- A. Comply with National Electrical Code.
- B. Unless otherwise noted maintain a unipoint ground scheme.
- C. Signal and electrical system grounds shall be isolated except at the Project ground field connection.
- D. Equipment enclosures shall not be permitted to touch each other unless bolted together and electrically bonded.
- E. Ground and bond equipment racks and similar equipment enclosures containing powered equipment exclusively via the Isolated Ground conductors provided under Division 26.  
INSULATE RACK MOUNTING, ANCHORAGE, AND RACEWAY CONNECTIONS.
- F. At each rack, provide an Isolated Ground bus within the rack. At each rack, provide a lug bonded to the rack frame with a #8 TW stranded wire to the rack Isolated Ground bus.
- G. At each ensemble of racks, provide a single labeled Isolated Ground tubular-clamp bus bar terminal strip to land the individual rack Isolated Ground bus ground conductors. Connect the main Isolated Ground conductor from the Technical Power panel board at this point.
- H. Equipment signal ground shall be to the Isolated Ground System via the green wire of the equipment power cord. Where equipment uses two wire power cord, provide #12 green bond wire to rack IG bus bar. At equipment, provide crimp lug and suitable hardware for bonding.
- I. Shielded cables of this section shall be grounded exclusively to Isolated Ground by a single path. Shield shall be tied to Isolated Ground at one end only, i.e., at the low potential (receiving) end of run, unless otherwise noted.
- J. Unless otherwise noted, at audio jackfields, tie source shield at jackbay frame. Float shields at connections to output jacks. Bus each row of jack frames and run individual #12 green ground wire for each row to rack IG bus bar.
- K. Signal Ground provisions shall realize less than 0.15 ohms to the primary ground connection.

3.11 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

- A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.
- B. Within each equipment enclosure, provide a full-height multi-circuit ISOLATED GROUND outlet strip with branch circuit count as shown on drawings; locate on the left side of the equipment enclosure, as viewed from the rear. In each enclosure provide number of receptacles required by present and future equipment indicated on drawings, plus at least two spare receptacles. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.
- C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.

- D. Maintain separation of wiring classifications as specified herein. Separately dress, route and land microphone and line level cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level and control cables on the left side of the equipment enclosure, as viewed from the rear.
- E. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.
- F. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.
- G. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.
- H. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible without cutting apart the harness.
- I. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.
- J. At each equipment backboard, provide UL Listed surge suppressing multi-outlet assembly with at least six receptacles.

### 3.12 ADJUSTING AND TESTING

- A. Test Equipment
  - 1. Furnish, store and maintain test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section. Maintain all test equipment at the job site while work is in progress from installation of equipment racks until Owner Acceptance of this Work; thereafter remove all of this test equipment from the job site. Provide all required test cables, jigs and adapters. Provide at least one of the following items or approved functional equivalents:
  - 2. Audio Systems:
    - a. Wide Band Oscilloscope (Tektronix THS700 Series).
    - b. True RMS Analog / Digital Volt-Ohm Multimeter (Fluke 187 Series or equal).
    - c. Low Distortion Audio Frequency Sine Wave Oscillator (Gold Line TS1).
    - d. Measurement Microphones (Earthworks M30, Bruel & Kjaer 4007, Josephson 550).
    - e. Sound System Optimization and Acoustic Measurement Analyzer (Goldline TEF, Meyers SIM, SIA Smaart, WinMLS, EASERA).
    - f. Harmonic Distortion Analyzer (Sound Technology or Tektronix AA 501A) or Swept Spectrum Analyzer, HP 3580A, or Swept Test System, Audio Precision or Neutrik).
  - 3. Video Systems:
    - a. Wide Band Oscilloscope (Tektronix THS700 Series).

- b. Sync & Test Generator (Tektronix 1470).
- c. Waveform/Vector Monitor (Tektronix 1740).
- d. Color Picture Monitor, Precision.
- 4. Communications and Related:
  - a. Level II, Cat5e Cable Pair Tester (Microtest, HP, Scope, Fluke or Siemons set up to meet Category 5e parameters).
  - b. Outside Plant Voice Cabling Plant Tester – capable of detecting shorts, opens, reversals, mis-wiring and crosstests (Siemon STM-8 or equal by Mod-Tap).
  - c. Metallic cable pair tester (Wavetek Corporation, Instruments Division, model LANTech 100).
  - d. Tone Test Set.
  - e. Optical Time Domain Reflectometer (OTDR) for fiber optics.
  - f. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.
- B. System Performance Testing and Adjusting Procedures
  - 1. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Review and Testing. Perform at least the following procedures:
  - 2. Mechanical: Verify:
    - a. Integrity of all support provisions.
    - b. Absence of debris of any kind, tools, etc.
  - 3. Power and Isolated Ground: Verify:
    - a. Isolation of Isolated Ground system from raceway and related ground.
    - b. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
    - c. Proper provision of power to devices and equipment.
  - 4. Signal Wiring: Verify:
    - a. Integrity of all insulation, shield terminations and connections.
    - b. Integrity of soldered connections. Absence of solder splatter, solder bridges.
    - c. Routing and dressing of wire and cable.
    - d. Continuity, including conformance with wire designations on running sheets, field and shop drawings.
    - e. Absence of ground faults.
    - f. Polarity.
  - 5. Use the proper sequence of energizing systems to minimize the risk of damage.
  - 6. Audio Systems:
    - a. Electronic Tests; confirm:
      - 1) Gain at 1 kHz.
      - 2) Maximum output.
      - 3) Input clipping level.
      - 4) Frequency response.
      - 5) Total harmonic distortion.
      - 6) Signal-to-Noise ratio.
      - 7) Signal-to-Crosstalk ratio.
    - b. Electro/Acoustic Tests:
      - 1) Uniformity of coverage.
      - 2) Electronic and acoustic frequency response/one-third octave equalization. Measure at ear level. Comply with applicable portions of SMPTE 202, "Motion-Pictures – Dubbing Theaters, Review Rooms, and Indoor Theaters – B-Chain Electroacoustic Response." Adjust to "curve X of

- B chain characteristic". Representative of the Owner will direct final adjustment.
- 3) Maximum continuous sound pressure level (in the reverberant field). Drive systems with broadband pink noise. Sustain for at least five minutes with no system damage. Measure for "A" and "C" weightings at ear level on loudspeaker axis. Turn off noise.
  - 4) Acoustic signal-to-noise ratio referenced to the specified maximum continuous sound pressure level in the reverberant field. Measure for "A" and "C" weightings at ear level on loudspeaker axis with mechanical systems operating. Present comparison with previous measurement.
  - 5) Acoustic gain before feedback. Locate acoustic source (4 inch loudspeaker/pink noise generator) two feet from system microphone. Measure at system microphone position and at most distant listener position at ear level. Present comparison.
7. Video Systems:
    - a. Video Monitors:
      - 1) Apply crosshatch. Verify linearity.
      - 2) Apply red field. Adjust purity.
      - 3) Apply SMPTE bars and PLUGE. Adjust to standards.
    - b. Video Path Test: Use NTC-7 procedures. Use full field or line signals. Alternately, conduct copper time domain reflectometer test.
  8. Diagnostic Monitoring System:
    - a. Demonstrate complete operation.
  9. System Overall:
    - a. Verify levels.
    - b. Provide permanent "wedge" type labels on all controls, as applies, to indicate correct settings after systems performance testing and adjustment procedures have been successfully completed.
- C. Loudspeaker Assembly Testing and Adjusting Procedures
1. Upon completion of the installation of all loudspeakers in an area, perform the following tests and record results. Correct non-conforming conditions, unless the cause is clearly outside the Work of this Section, in which case submit the apparent cause to the Owner.
  2. Loudspeaker Line Impedance: At terminal cabinets at equipment rooms, measure the impedance of each loudspeaker line. Sweep from at least 20 Hz to at least 16 kHz.
  3. Loudspeaker Polarity: Test the acoustic polarity of all loudspeakers using an Acoustic Polarity Tester.
  4. Freedom From Buzzes, Rattles and Objectionable Distortion: Individually apply to each loudspeaker line a slow sine wave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles and objectionable distortion.
  5. Uniformity of Coverage: Apply broadband Pink Noise. Adjust level to approximately 70-80 dBA at measurement locations. Measure in 4 kHz octave band at ear level. Adjust loudspeaker aiming and 70 Volt loudspeaker taps for uniformity of coverage.
- D. Equipment Rack and Equipment Testing and Adjusting Procedures
1. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report with color photographs of each equipment rack, front and back. Perform at least the following procedures:
  2. Preliminary: Verify:



- a. Grounding of devices and equipment. Integrity of signal and electrical system ground connections.
  - b. Proper provision of power to devices and equipment.
  - c. Integrity of all insulation, shield terminations and connections.
  - d. Integrity of soldered connections. Absence of solder splatter, solder bridges.
  - e. Absence of debris of any kind, tools, etc.
  - f. Routing and dressing of wire and cable.
  - g. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.
  - h. Mechanical integrity of all support provisions.
- 3. Rig temporary power and grounding: Comply with all applicable Codes, regulations and ordinances.
  - 4. Determine the proper sequence of energizing systems to minimize the risk of damage. Energize. Burn in for at least 120 hours.

### 3.13 CLEANING

- A. Clean each section or area of where the work was conducted after completion to permit immediate use of the area. Remove and discard all refuse, rubbish, and debris.
- B. The Contractor shall ensure that all recyclable and environmentally-hazardous waste materials are disposed properly.
- C. Make good all existing structures, surfaces, and utilities affected by cutting, coring, mounting, drilling, or other new work.
- D. Clean all furnished equipment of dust, dirt, finger prints, smudge, and other material prior to calling for a Substantial Performance of Work Review or Completion of Work Review.

### 3.14 PROTECTION

- A. During the installation phase and up to the date of achieving Substantial Performance of Work, protect finished or unfinished work against damage or loss. In the event of such damage or loss, immediately replace or repair such work or equipment at no cost to the Owner.

### 3.15 ACCEPTANCE REVIEW AND TESTING PROCEDURES

- A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Owner in writing that the Work of this Section is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing by returning Attachment "A" to the Design Consultant. The representative of the Owner will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These Procedures may be performed at any hour of the day or night as required by the representative of the Owner to comply with the Project Schedule and avoid conflict with these procedures from possible ongoing work of other Separate Contracts and/or the Owner's operations. Provide all specified personnel and equipment at any time without claim for additional cost or time.
- B. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this Section. Provide quantity of technicians as required to comply with Project Schedule.
- C. In Addition, Provide:
  - 1. Set of hand and power tools appropriate for performance of adjustment of and corrections to this Work.

2. Include spare wire and connectors and specified tooling for application.
  3. Ladders, scaffolding and/or lifts as required to access loudspeakers and other high devices.
  4. Test equipment to include but not limited to:
    - a. Dual channel FFT-based audio analyzer
    - b. Video test generator with color bars, grayscale, alternating pixel, multi-burst, crosshatch and % windows.
    - c. InfoComm Projection Shoot-Out DVD
    - d. Digital Video Essential Professional DVD
    - e. Category cable tester, cable length, short, open and miswire test.
  5. Complete set of latest stamped, actioned submittals of record for reference.
  6. Complete set of Shop and Project Site Test Reports.
  7. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
- D. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
1. General
    - a. Configure room for each type of event and demonstrate audio-visual system.
    - b. Connection of portable equipment. (Laptop, document camera, etc.)
    - c. Demonstrate to the Consultant that all functions and equipment for the system work properly when installed as a complete system.
    - d. The Contractor shall demonstrate the satisfactory operation of all controls and adjustment circuits of the system.
    - e. Demonstrate system startup and shut down procedures.
  2. Audio
    - a. Route audio to program speakers.
    - b. Connect microphone to each panel input and route through system.
    - c. Demonstrate and document gain structure through the system.
    - d. Audio routed to ceiling speakers.
    - e. Wireless microphones.
    - f. Assistive listening system.
  3. Video
    - a. Route source equipment (DVD, VCR, TV tuner, test generators, etc.) to video displays and projector.
    - b. Set up rooms for each type of event that may take place and demo each.
  4. Control
    - a. Communication between control system and AV equipment, including feedback if device supports 2-way communication
    - b. User interface operation.
    - c. Password protection of user interface.
    - d. Touch panel features and each page of control.
    - e. Touch panel help file.
    - f. Help desk features.
    - g. All programmed presets.
  5. The Contractor 's personnel and test equipment shall be made available to the Consultant in order that:
    - a. Selected tests and measurements previously made by the Contractor can re-run.
    - b. Other tests may be made at Consultant's discretion.
    - c. Additional tests or measurements may be made due to changes in field conditions.
  6. It is estimated that the acceptance tests and demonstrations will require approximately two hours, unless construction or installation problems or deviations from the specifications are discovered.

- E. Adjust: As directed by the representative of the Owner.
- F. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the representative of the Owner.
- G. Acceptance Documentation
  - 1. Official acceptance of the system covered by this specification will occur when the Design-Builder receives the following written documents:
    - a. A letter from the Consultant to the Architect acknowledging Final Acceptance of the system stating compliance with all articles of the specifications.
    - b. A letter from the Architect to the Contractor stating that all related work has been completed to his satisfaction. Until these documents are received, the installation is not formally complete. The official date of acceptance shall be the date of the letter from the Architect to the Contractor described above.

### 3.16 CLOSEOUT

- A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify Owner of completion of Punch List.
- B. Portable Equipment: Furnish all portable equipment and spares to the designated representative of the Owner, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
- C. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.
- D. Project Record Documents: Submit.
- E. Keys: If applicable, replace construction locks with permanent locks. Transmit keys to Owner.
- F. Training: Conduct specified training and submit training manuals.
- G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

### 3.17 OWNER'S RIGHT TO USE EQUIPMENT

- A. Acceptance of the Work of this Section will be after completion of corrections and adjustments required by the "Punch List" which results from Acceptance Review and Testing of the completed installation. The Owner reserves the right to use equipment, material and services provided as part of the Work of this Section prior to Acceptance without incurring any obligation to Accept any equipment or completed systems until all Punch List work is complete and all systems comply with the Contract Documents; or accept any claim for additional cost or time.

**Attachment "A"**

**NOTICE OF COMPLETION  
&  
REQUEST FOR FINAL INSPECTION**

We hereby give notice that the work associated with the Audio-Visual system, at the project named below, is completed and fully complies with the contract documents issued to the Contractor. The required submittals below have been marked as completed.

- |   |  |
|---|--|
| <input type="checkbox"/> Programming        | <input type="checkbox"/> Training Manual       |
| <input type="checkbox"/> Test Reports       | <input type="checkbox"/> Training              |
| <input type="checkbox"/> Operation Manual   | <input type="checkbox"/> Warranty Certificates |
| <input type="checkbox"/> Maintenance Manual | <input type="checkbox"/> Record Drawings       |

We request commissioning and verification testing be scheduled with the Owner's Representative for final system sign off. Attached is a list of test equipment for review and acceptance.

**PROJECT INFORMATION**

Project Name:	Project Phase:
Project Address:	

**CONTRACTOR INFORMATION**

Name:	Company:
Address:	
Signature:	Date:

Note to Contractor: Provide all test equipment for final inspection as described in the specification.

**Please complete and fax or email this form to Veneklasen Associates attention AV Department**  
**Fax (310) 396-3424                      Email [dyoung@veneklasen.com](mailto:dyoung@veneklasen.com)**

END OF SECTION

# **DIVISION 31**

## **EARTHWORK**

## SECTION 31 10 00 - SITE CLEARING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Protecting existing trees to remain.
  - 2. Removing existing trees, shrubs, groundcovers, plants and grass.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Removing above- and below-grade site improvements.
  - 6. Disconnecting, capping or sealing, and removing site utilities.
  - 7. Temporary erosion and sedimentation control measures.
- B. Related requirements: Division 01, Section 01 81 13, "Sustainable Design Requirements", and Division 1, Section 01 74 19, "Construction Waste Management"

#### 1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

#### 1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site-clearing operations until temporary erosion and sedimentation control measures are in place.

### PART 2 - PRODUCTS (Not Applicable)

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.

- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### 3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

### 3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. 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 not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.

### 3.5 CLEARING AND GRUBBING

- A. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

### 3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION



## SECTION 31 20 00 - EARTH MOVING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
  - 2. Excavating and backfilling for buildings and structures.
  - 3. Drainage course for slabs-on-grade.
  - 4. Base course for concrete pavements.
  - 5. Base course for asphalt paving.
  - 6. Excavating and backfilling for utility trenches.
- B. Related requirements: Division 01, Section 01 81 13, "Sustainable Design Requirements", and Division 1, Section 01 74 19, "Construction Waste Management"

#### 1.2 QUALITY ASSURANCE

- A. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

#### 1.3 REFERENCES

- A. This specification section has been prepared using the project soils report *Report of Geotechnical Engineering Services* by GeoDesign, Inc., dated October 8, 2010 as a reference.

#### 1.4 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subgrade and hot-mix asphalt or concrete paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Classified Excavation: Removal and disposal of materials not defined as rock
- F. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

- G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.
- K. Unclassified Excavation: Removal and disposal of materials encountered regardless of nature of materials, including rock.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### 1.5 PROJECT CONDITIONS

- A. Examine site, Drawings, records of existing utilities and construction, record of test borings, and subsurface exploration report available from Owner. Records of test borings are for information only and are not guaranteed to represent all conditions that will be encountered.

#### 1.6 PROTECTION

- A. Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.
- B. Existing Utilities:
  - 1. Maintain existing utilities that are to remain in service. Before excavating over or adjacent to existing utilities, notify utility Owner to ensure protective work will be coordinated and performed in accordance with utility Owner's requirements. If existing service lines, utilities and utility structures, which are to remain in service, are uncovered or encountered during these operations, safeguard and protect from damage.
  - 2. Within limits of excavation, remove existing piping, subsoil drainage systems, conduit, manholes and relocated items, which are to be abandoned. Plug open ends of utilities to remain with concrete.
  - 3. Re-route existing subsoil drains which obstruct work around new constructions, or incorporate them into new drainage systems.

4. Consult Architect immediately for directions, should uncharted or incorrectly charted piping or other utilities be encountered during excavation. Cooperate with Owner and public and private utility companies in keeping their respective services, utilities and facilities in operation. If damaged, repair utilities to satisfaction of Architect and utility Owner.
- C. Existing Facilities: Protect and maintain in satisfactory manner, existing pavements, curbs, gutters, structures, conduits, fences, walls and other facilities to remain above and below grade. Restore facilities damaged by construction operations.
- D. Pumping and Draining: Excavate areas in such manner as to afford adequate drainage. Control grading in vicinity of excavated areas so ground surface will slope to prevent water running into excavated areas. Until work is completed, remove water from areas of construction that may interfere with proper performance of work or that may result in damage to the soil sub-grade and provide sumps, pumps, well points, electric power and attendance required for this purpose on a 24 hour basis if necessary. Protect construction from water during construction, including prevention of erosion of completed work during construction and until permanent drainage and erosion controls are operational. Repair adjoining properties, facilities and streets damaged due to improper protection.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Sand, gravel, friable earth, or non-expansive clays, subject to Testing Laboratory's approval. Fill and backfill material shall be free of organic material, slag, cinders, expansive soils, trash or rubble and stones having maximum dimension greater than **[6 inches]**.
- C. Unsatisfactory Soils: Expansive and other soils as defined in the project's geotechnical investigation report.
  1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Base Course: Material conforming to SSPWC section 200-2.2, Crushed Aggregate Base or SSPWC section 200-2.4 Crushed Miscellaneous Base.
- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- F. Bedding Course: Crushed rock conforming to SSPWC Section 200.1-2 and Table 306-1.2.1.3 (B).
- G. Drainage Course: Narrowly graded mixture of washed, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

### 2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility. Color coding shall be according to the American Public Works Association (APWA) standards:
  - 1. Blue – Potable water and fire suppression lines.
  - 2. Green – Sanitary sewer and storm drain lines
  - 3. Orange – Communication, alarm or signal lines
  - 4. Purple – Reclaimed water, irrigation, and slurry lines
  - 5. Red – Electrical power lines, cables, conduit and lighting lines
  - 6. Yellow – Gas, oil, steam, petroleum, or gaseous material lines.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- 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. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing" or "Demolition".
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing" or "Demolition," during earthwork operations.

#### 3.2 EXCAVATION

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

#### 3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

#### 3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

#### 3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.

- B. Excavate trenches to uniform widths to provide 6 inch 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, unless otherwise indicated.
- C. 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 projecting stones and sharp objects along trench subgrade.
  - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

### 3.6 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

### 3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

### 3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- D. Place and compact final backfill of satisfactory soil to final subgrade elevation.

- E. Install warning tape directly above utilities, minimum 6 inches above top of pipe, minimum 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use engineered fill.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use engineered fill.
  - 5. Under footings and foundations, use engineered fill.

### 3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 6 inches of existing subgrade and each layer of backfill or fill soil material to 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material to 90 percent.
  - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material to 85 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material to 90 percent.

### 3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

### 3.14 BASE COURSES

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
1. Shape base course to required crown elevations and cross-slope grades.
  2. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

### 3.15 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

### 3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

### 3.17 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION



# **DIVISION 32**

## **EXTERIOR IMPROVEMENTS**

## SECTION 32 12 16 - HOT-MIX ASPHALT PAVING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes hot-mix asphalt paving.
- B. Related requirements: Division 01, Section 01 81 13, "Sustainable Design Requirements"

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material certificates.
- D. Log of placement of asphalt, including dates, times, temperature readings and other pertinent information.
- E. LEED certification data as specified in Division 1, Section 01 81 13, "Sustainable Design Requirements", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured and Harvested / Extracted Locally.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC) and the California Department of Transportation (Caltrans), latest editions and supplements for asphalt paving work. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.
- C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

#### 1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
  - 1. Tack Coat: Minimum surface temperature of 60 deg F.
  - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

## PART 2 - PRODUCTS

### 2.1 AGGREGATES

- A. Coarse Aggregate: Crushed rock conforming to SSPWC 400-4.2.3.
- B. Fine Aggregate: Sand, rock dust, mineral filler, or a blend of these materials conforming to SSPWC 400-4.2.4. Mineral filler, if required, shall conform to SSPWC section 203-6.2.3.

### 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: Paving asphalt, viscosity grade PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.
- B. Tack Coat: PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.
- C. Mixes: Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mix III-C3 PG 64-10 designed in conformance with SSPWC Section 400-4.

### 2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

## PART 3 - EXECUTION

### 3.1 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
  1. Mill to a depth of 1-1/2 inches.

### 3.2 SURFACE PREPARATION

- A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
  1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

- C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Spread mix at minimum temperature of 250 deg F.
  - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.4 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.5 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch.
  - 2. Surface Course: Plus 1/4 inch (no minus).
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch
  - 2. Surface Course: 1/8 inch
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

### 3.7 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

## SECTION 32 13 13 - CONCRETE PAVING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
  - 1. Driveways and roadways.
  - 2. Parking lots.
  - 3. Curbs and gutters.
  - 4. Walkways.
- B. Related requirements: Division 01, Section 01 81 13, "Sustainable Design Requirements"

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, including admixtures.
- B. Design Mixtures: For each concrete pavement mixture.
- C. LEED certification data as specified in Division 1, Section 01 81 13, "Sustainable Design Requirements", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured and Harvested / Extracted Locally.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- C. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
- D. The Contractor shall have one copy of the Standard Specifications at the job site.
- E. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.

### PART 2 - PRODUCTS

#### 2.1 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

## 2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
  - 1. Portland Cement: ASTM C 150, Type II, low alkali. Supplement with the following:
    - a. Pozzolan: ASTM C618, Class F or N Fly Ash, 100 pounds maximum per cubic yard, containing one percent or less carbon. Fly ash shall not be used in excess of 15 percent by weight of total cement quantity.
- B. Combined Aggregates: Gradation "C" conforming to SSPWC Section 201-1.3.2.
- C. Water: ASTM C 94/C 94M.

## 2.3 CURING MATERIALS

- A. Liquid Curing Compound: ASTM C309, fugitive dye dissipating type, complying with Rule II 13 of the South Coast Air Quality Management District and Federal Air Quality Regulation 40 CFR 52.254.
- B. Moisture-Retaining Cover (Curing Sheet): ASTM C 171, non-staining polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

## 2.4 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

## 2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:
  - 1. Compressive Strength (28 Days): 2,500 psi
  - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.60
  - 3. Slump Limit: 4 inches, plus or minus 1 inch.

## 2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates to Architect for each batch discharged and used in the Work.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

#### 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, placing, and supporting reinforcement.

#### 3.4 JOINTS

- A. General: Form construction, isolation, and control 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.
- 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.
- 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.
- D. Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of the concrete thickness to match jointing of existing adjacent concrete pavement.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

#### 3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. 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.
- D. Screed pavement surfaces with a straightedge and strike off.



- E. Commence initial floating using bull floats or darbies to impart 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 or spreading surface treatments.

### 3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
  - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions.
  - 1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  - 2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

### 3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. 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 before and during finishing operations. Apply according to manufacturers written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

### 3.8 PAVEMENT TOLERANCES

- A. Comply with tolerances as follows
  - 1. Elevation: 1/4 inch
  - 2. Thickness: Plus 3/8 inch minus 1/4 inch
  - 3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed 1/4 inch.
  - 4. Joint Spacing: 3 inches.
  - 5. Contraction Joint Depth: Plus 1/4 inch no minus.
  - 6. Joint Width: Plus 1/8 inch, no minus.

### 3.9 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.
- C. 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 13 16 - DECORATIVE CONCRETE PAVEMENT

### PART 1.0 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Furnishing of services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings and specified herein as required to properly complete the work in this contract.
- B. This Section includes the following:
  - 1. Cement concrete pavement.
- C. Related Sections include the following:
  - 1. Section 01 10 10 - Sustainable Design Requirements.
  - 2. Division 03 Section "Cast-In-Place Concrete" for formwork; material, fabrication, and installation requirements for steel reinforcement; and field quality control.
  - 3. Division 03 Section "Landscape Architectural Concrete" for formwork; material, fabrication, and installation requirements for steel reinforcement; and field quality control.
  - 4. Division 05 Section "Pipe and Tube Railings" for fabrication and installation requirements for pipe and tube railings.
  - 5. Division 31 Section "Site Clearing" for removal limits of trees, shrubs, and other plantings affected by new construction.
  - 6. Division 31 Section "Earth Moving" for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
  - 7. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in contraction and other joints in cast-in-place Landscape Architectural concrete.
  - 8. Division 32 Section "Plants" and "Turf and Grasses" for coordination with adjacent planting areas.
  - 9. Division 32 Section "Planting Irrigation" for coordination with adjacent irrigation systems.
  - 10. Division 32 Section "Decorative Concrete Paving"
  - 11. Division 32 Section "Lithocrete Architectural Concrete Paving"
  - 12. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

#### 1.2 REFERENCES

- A. Conform to the following codes and standards:
  - 1. Section 01 10 10 - Sustainable Design Requirements.
  - 2. American Concrete Institute (ACI)

3. American Society" for Testing and Materials (ASTM): The specifications and standards hereinafter referred.
4. Standard Specifications for Public Works Construction 2000

B. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

### 1.4 SUBMITTALS

- A. Comply with Section 01330 Submittal Procedures and Section 01 10 10 - Sustainable Design Requirements.
- B. Product Data: Furnish manufacturer's product specifications and installation instructions for the following and for each type of product indicated.
1. Clear sealer
  2. Curing agents
  3. Dowels
  4. Expansion joint filler material
  5. Fiber reinforcement
  6. Finish retardant
  7. Form release agent
  8. Integral color/ color admixture
  9. Joint sealant
- C. Products; Submit one pound samples, clearly identified, for each component used to prepare each paving type, including but not limited to:
1. Coarse Aggregate
- D. Design Mixtures: Furnish certified reports of proposed mix design for each type of concrete installation. For each decorative cement concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Provide documentation for each paving type specified on Drawings that will enable Design Consultant's to better match replaced concrete:
  2. Submit laboratory test reports for concrete materials and a certificate with each concrete mixer truck, stating mix design, PSI, rating, slump, water and cement quantity, cement/water ration, fine and coarse aggregate and color additives.

- a. Cement:
    - i. Manufacturer and plant location.
    - ii. Cement type, i.e. Type I, II, III, or V.
  - b. Admixtures:
    - i. Manufacturer and plant location.
  - c. Sand:
    - i. Source and Type.
  - d. Aggregates:
    - i. Source and Type.
  - 3. Signed certification from a licensed structural engineer.
- E. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Control" and as supplemented in "Quality Assurance" Article.
- 1. Qualification Data: For Contractor.
    - a. Contractor: Provide evidence to indicate successful experience in providing decorative concrete work similar to that specified herein and can demonstrate successful experience through past Project documentation and references.
    - b. Experience: Minimum 5 years experience in the installation of patterned concrete paving.
    - c. Demonstration of Experience: 10 Projects which have been completed within the past 36 months utilizing similar products, scope and complexity.
    - d. Supervision: Perform placement and finishing of concrete work under supervision of a person having a minimum of 5 years of experience in placement and finishing of products specified herein.
  - 2. Submit qualifications to Design Consultant for information purposes. Submit a resume of Project Manager and Superintendent who will be overseeing the Work.
  - 3. Minutes of preinstallation conference.
  - 4. Delivery slips.
- F. Certification that Design Consultant's sample panels (if provided) have been reviewed and that materials and processes provided will achieve intended effects indicated on Design Consultant's sample panel.

- G. Submittals for above items shall be made in one package. If submittals are judged incomplete or non-responsive to the directions of the Design Consultant after three submissions the Contractor shall be back charged for the Design Consultants costs to process additional Submittals. Additional Submittal Procedures are specified in Section 01300.
- H. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.5 QUALITY ASSURANCE

- A. Contractor Qualifications: An employer of workers trained and approved by manufacturer of decorative cement concrete pavement systems.
- B. Pre-Bid Conference: Prior to submitting bid, attend pre-bid conference with Design Consultant to review Design Consultant's production run quality samples of specified concrete colors and finishes and to review requirements and artistic effect desired.
- C. Slip Resistance: Provide a finish surface slip resistance coefficient of friction equal or greater than 0.6 for flat surfaces and 0.8 for ramps, when tested in accordance with ASTM F 489.
- D. Ready-Mix-Concrete Producer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Producer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- E. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- F. Source Limitations: Obtain decorative cement concrete pavement products and each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate through one source.
- G. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- H. Concrete Testing Service: Engage a qualified independent testing agency to perform

material evaluation tests and to design concrete mixtures.

- I. Referee Panels: The Design Consultant will provide production run quality samples of specified concrete paving colors and finishes to be used as Referee Panels to judge the Field Mock-ups. The Design Consultant will provide information and assist the Contractor on the mix design components used to achieve the Referee Panels.
- J. Mockups:
  - 1. Cast mockups of sections approximately 60inches by 60-inches of decorative cement concrete pavement to demonstrate typical pattern, texture, surface finish, color, joints, caulking, sealer and standard of workmanship.
  - 2. Build mockups in the location and of the size indicated or, if not indicated, as directed by Design Consultant. Include joints and joint materials, caulking, sealer and scoring treatments specified on the plans.
  - 3. If multiple colors and finishes are specified, samples are required for each paving type and mock ups shall be prepared for review at the same time.
  - 4. In presence of Design Consultant, damage part of the exposed surface of decorative cement concrete pavement for each finish, color, and texture required, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
  - 5. The Mock-ups shall be reviewed and approved by the Design Consultant before proceeding with the work. Mock-ups will be judged against the appearance of the Referee Panels. Mock-ups that do not match the Referee Panels and do not demonstrate all specified joints and joint materials, caulking, and scoring treatments will be rejected. Remove and reconstruct the mock-ups until approved. The Contractor shall be back charged for the costs of the Design Consultant to review more than two mock-up attempts. Approved mock-ups shall serve as standard of acceptance for paving work and remain available for the duration of the project.
  - 6. Demolish and remove mock-ups at the completion of the project.
- K. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings" and Quality Control."
  - 1. Before submitting design mixtures, review decorative cement concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and decorative cement concrete pavement construction practices. Require representatives of each entity directly concerned with decorative cement concrete pavement to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixes.

- c. Ready-mix concrete producer.
- d. Decorative cement concrete pavement Contractor.

2. Manufacturer's representative of decorative cement concrete pavement system.

L. Formwork: Comply with Recommended Practice for Concrete Formwork, ACI 347.

#### 1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

#### 1.7 DELIVERY AND HANDLING

- A. Conform to Section 01600 Product Requirements.
- B. Deliver, store, and handle reinforcement to prevent damage.

#### 1.8 REGULATORY REQUIREMENTS

- A. Testing: Slump tests shall be taken to certify compliance with mix design. Slump shall be in accordance
- B. Mix design shall be in accordance with ACI 211-6.with ASTM C 143.
- C. Conform to applicable laws, codes, and regulations required by authorities having jurisdiction over the work.

#### 1.9 SITE CONDITIONS

A. Do not place concrete when subbase surface temperature is less than 40 degrees F, nor when surface is wet.

#### 1.10 COORDINATION

- A. In accordance with Section 03 20 03.
- B. Ensure that irrigation sleeves, electrical conduit, food cart outlets, and other utility elements are accommodated and as-built located prior to pouring concrete.

#### 1.11 INSPECTION OF SITE

A. Verify conditions at site affect Work of this Section, and take field measurements as requires. Report major discrepancies between Drawings and field dimensions to Design Consultant prior to commencing work.



## **PART 2.0 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. Products: Subject to compliance with requirements, provide one of the products specified.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### **2.2 FORMS**

- A. Form Materials: Either steel or wood, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are free of distortion and defects.
- B. Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - 1. Use flexible or curved forms for curves of a radius 100 feet or less.
  - 2. Flexible spring steel forms, laminated boards, or bender boards to form radius bends as required.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.
  - 1. Form work to be new, #2 grade Douglas Fir, free of knots, checks, bows, and cracks.
- D. Form-Release Agent: A non-staining form release compound that will not discolor or deface the surface of the concrete. 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.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  - 2. Final acceptance of form release agent depends on proven performance on mock up panels.
  - 3. Acceptable Manufacturers:
    - a. Atlas Release (858) 277-2100

## 2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets. 6 x 6 x W4.0 x W4.0 conforming to ASTM A 185. Furnished in flat sheets, not rolls, unless otherwise accepted by the Design Consultant.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
  - 1. Grade 40 or 60 billet steel conforming to ASTM A 626/615M. Bending process shall conform to the Manual of Standard Practice of the Concrete Reinforcing Steel Institute. Kinked bars shall not be used.
  - 2. Reinforcing Steel: Conforming to ASTM A 615, clean and free of rust, dirt, grease or oils.
- C. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- D. Plain Steel Wire: ASTM A 82, as drawn.
- E. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- F. Plastic dowel alignment sleeves Products:
  - 1. Speed Dowel or equal (no known equal).
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, 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:
- H. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- I. Polypropylene Fiber Reinforcement: 100% virgin multifilament polypropylene fibers, engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116 - Type III.
  - 1. Acceptable Manufacturers:
    - a. Fibermix®; Stealth® Fibers – 1/4" long (423)892-8080 or [www.fibermesh.com](http://www.fibermesh.com).
    - b. Forta Fiber; Microfiber (800)245-0306.
    - c. Grace Construction Products; Microfiber™ (800)433-0020 or [www.grace.com](http://www.grace.com).
  - 2. Application Rate: 1/2 lb./cy of mix.

## 2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Gray Portland Cement: ASTM C 150, Type II
- B. Refer to Drawings for specific paving finishes requiring different cement types, to include Type II cements (unless otherwise identified in the Drawings) conforming to ASTM C 150.
- C. Use same brand of cement from single source throughout entire Project for each paving type.
- D. Refer to Statement of Mix Design for cement type used.
- E. Fly Ash: ASTM C 618, Class F.
- F. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- G. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
- H. Maximum Aggregate Size: Refer to Drawings for maximum aggregate size.
- I. Coarse Aggregate: Aggregate composed of gravel, crushed rock, or a blended mixture conforming to Standard Specifications Section 200-1.4. Aggregates shall be washed clean, uniformly screen graded, and contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth loam, mica, or similar materials.
- J. Clean, hard, and durable coarse aggregate, conforming to ASTM C 33.
- K. Use same coarse aggregate from single source throughout entire Project.
- L. Refer to Statement of Mix Design for coarse aggregate type used.
- M. Aggregates shall be washed clean, uniformly screen graded, and contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth loam, mica, or similar materials.
- N. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
  - 1. Sand shall consist of a natural or manufactured granular material, or combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended. Sand shall be washed and conform to Standard Specifications Section 200-1.5.3.

- O. Clean, hard, and durable washed concrete sand, conforming to ASTM C 33.
- P. Use same fine aggregate from single source throughout the entire Project.
- Q. Refer to Statement of Mix Design for fine aggregate type used.
- R. Sand shall be free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended.
- S. Base Material: Washed concrete sand, uniformly graded and meeting the requirements of Standard Specifications Section 200-2.2. At the time of spreading, the material shall have a moisture content sufficient to obtain the required compaction.
- T. Structural Soil Base: Structural “CU” soil base material available through Hanson Aggregates (refer to Structural Soil specification Division 32. Refer to drawings for extend of concrete paving on structural soil.
- U. Water: Potable and complying with ASTM C 94/C 94M. Free from deleterious materials such as oils, acids, and organic matter.
- V. Air-Entraining Admixture: ASTM C 260.
- W. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

## 2.5 ADMIXTURES

- A. Provide concrete admixtures that contain not more than 1 percent chloride ions and no calcium chloride.
- B. Water-Reducing Admixture: ASTM C 494, Type A.
- C. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- D. Water-Reducing and Retarding Admixture: ASTM C 494, Type D or E.
- E. Acceptable Manufacturers:
  - 1. Water-Reducing Admixtures:

- a. ChemMasters Corp; Chemtard.
  - b. Cormix Construction Chemicals: Type A Series.
  - c. Euclid Chemical Company; Eucon WR-75.
2. High-Range Water-reducing Admixtures:
- a. Anti-Hydro Co. Inc.: super P.
  - b. Cormix Construction Chemicals: Cormix 2000, PSI Super.
  - c. Euclid Chemical Company; Eucon 37.
3. Water-Reducing and Acceleration Admixtures:
- a. Conspec Marketing & Manufacturing Company; Q-Set.
  - b. Cormix Construction Chemicals; Gilco Accelerator or Lub NCR.
  - c. Euclid Chemical Company; Lithochrome Surface Retarder.

## 2.6 COLOR MATERIALS

- A. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[free of carbon black, nonfading, and resistant to lime and other alkalis.
- B. Integral Color: Integrally color concrete in colors, blending mixtures and application rates necessary to create colors, gradations, and variations to match Design Consultant's mock-up.
- C. Manufacturers:
  1. As listed on the Drawings or As selected by the Design Consultant.

## 2.7 CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per square yard, complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following complying with ASTM C 171:
  1. Waterproofing paper.
  2. Polyethylene film.
  3. White burlap-polyethylene sheeting.
- C. Clear, Waterborne Membrane-Forming Curing Compounds:
  1. Provide curing materials that have a maximum volatile organic compound (VOC) rating of 350 g/l.
- D. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete

slab surfaces for temporary protection from rapid moisture loss.

1. Clear, Waterborne Membrane-Forming Curing Compounds Acceptable Manufacturers:
    - a. Anti-Hydro Company; Clear Cure Water Base.
    - b. The Burke Company; Spartan Cote WB.
    - c. Cormix Construction Chemicals; Sealco VOC.
  2. Acceptable Evaporation Control Manufacturers:
    - a. Conspec Marketing and MFG. Company; Aquafilm.
    - b. Euclid Chemical Company; Eucobar.
    - c. L&M Construction Chemicals; E-Con.
- E. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, complying with ASTM C 171.
- F. Surface Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products:
    - a. Top Cast/Top Face by Grace Products
    - b. Rugasol
- G. Sealer: Waterbased Clear siloxane or silane penetrating sealer. Acceptable products include, but not limited to:
- a. Prosoco SLX100 Stand Off
  - b. Aquapel Plus, L&M Construction Chemicals.(800) 362-3331
  - c. Glaze n' Seal, Natural Look or Wet Look
  - d. Colorcure Curing Agent and Concrete sealer with integral color, L.M.Scofield Company;
  - e. CureSeal Curing Agent and Clear Sealer. L.M. Scofield Company
  - f. Cementone Clear Sealer. L.M.Scofield Company;
  - g. Barcade WB ORS The Euclid Chemical Company
  - h. VOCOMP – 20R, WR Meadows Sealtight
  - i. Superstone; Clear Sealer.
  - j. Lambert; Clear Sealer.
  - k. Weather Worker J-26 WB
- H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, specifically manufactured for use with colored concrete.
1. Products:
    - a. Cureseal, Scofield

## 2.8 JOINT MATERIALS

A. Expansion- and Isolation-Joint Materials: -

1. Filler Strips: Premoulded material, 3/8" thick, depth as required by slab, of resilient, non-bituminous material, depth as required by slab.

2.9 RELATED MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

2.10 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 and ACI 318, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
1. Mix design shall be the responsibility of the Contractor.
  2. Contractor shall employ a Testing Laboratory approved by the Design Consultant under the active direction of the Design Consultant, who shall determine mix designs to fulfill the specified requirements for strength, aggregate size and workability of concrete, and such designs shall be used in proportioning structural concrete.
  3. Mix designs shall be submitted to the Design Consultant for review at least 10 days prior to scheduled concrete pour.
  4. Review by the Design Consultant shall not be considered unqualified approval, and shall not relieve the Contractor of his responsibility to furnish concrete of proper consistency and specified strengths.
  5. Provide concrete of the strengths indicated in the structural general notes
  6. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): As indicated in the Drawings or 2500 psi.
  2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.61
  3. Slump Limit: 5 inches.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 2 percent
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water reducing admixture and retarding admixture [and accelerating admix-

ture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

## 2.11 PAVING TYPES

- A. Concrete Paving Types 1: Refer to landscape drawings for concrete paving types and finishes
- B. Color Pigment: Add color pigment or colored water-reducing admixture to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
  1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

## PART 3.0 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the site and verify that no defects or errors are present that would cause defective installation or latent defects in the workmanship and function. Report unsatisfactory conditions to the Design Consultant. Do not begin paving work until unsatisfactory conditions have been corrected and the area is ready to receive the work. Continuing with the installation constitutes acceptance of the unsatisfactory conditions and responsibility for satisfactory performance.
- B. Verify that paving subgrade consists of a minimum of 4-inches of compacted washed concrete sand, passes less than 7% through a #200 sieve, and is compacted to at least 95% of the materials ASTM D 1557 maximum dry density for its full depth.
- C. Verify that paving subgrade extends 1-foot beyond the outside edge of paving or curbing and has positive outfall for trapped water.
- D. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- E. Remove loose material from compacted subbase immediately before placing concrete.
- F. Provide necessary chairs or supports, and maintain position of reinforcing bars.



- G. Wet surface of sand subgrade prior to placing concrete.
- H. Examine exposed subgrades and subbase surfaces for compliance with tolerances for dimensional, grading, and elevation tolerances.
- I. Proof-roll prepared subbase surface with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
- J. Completely proof-roll subbase in one direction[ and repeat in perpendicular direction]. Limit vehicle speed to 3 mph.
- K. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
- L. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/4 inch require correction according to requirements in Division 2 Section "Earthwork."
- M. Proceed with decorative cement concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.
- N. Synthetic Fiber reinforcement; ½ lb. per cubic yard of mix added at batch plant.
- O. Adjustment to Concrete Mixes: Mix design adjustments may be required by Contractor when characteristics of material, Project conditions, weather, test results, or other circumstances warrant.
- P. Coordinate with other trades, placement of accessories, chases, and other embedded items. Provide sufficient time to complete installation of their work.

### 3.2 SURFACE PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.
- C. Subgrade Preparation: Unless noted otherwise, subgrades shall be compacted to a relative density as specified in the soils report, and to elevations necessary to achieve the finished surface indicated. Semi-porous subgrades shall be sprinkled sufficiently with water to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.
- D. Base Preparation: Where indicated, washed concrete sand or structural "CU soil base material shall be deposited at a uniform quantity that will provide the required compacted thickness within ¼" above or below the grade determined from the Drawings. The relative compaction of the base material shall not be less than specified in the soils report. Compacted areas that do not conform to the requirements specified, shall be reworked,

watered, and thoroughly re-compacted to conform to the specified requirements.

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Shall conform to the shape, lines, and dimensions as called for on the Drawings.
- B. Completed formwork shall be free of hardened concrete, washed clean and shall have excess water removed, reinforcement secured in place, expansion joint material and other embedded items positioned, forms shall be thoroughly cleaned, washed out with water, and made tight. Before reinforcing steel is placed on top of or adjacent to forms that have been sealed, the surface sealer shall be wiped off so that none may be tracked over or come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.
- C. 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.
- D. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage
- E. Check completed formwork and screeds for grade and alignment to following tolerances:
  - 1. Top of Forms: Not more than 1/8-inch in 10-feet.
  - 2. Vertical Face on Longitudinal Axis: Not more than 1/4-inch in 10-feet.
  - 3. Joints and Corners: Construct forms such that joints occur at approved locations. Form intersecting planes to provide true, crisp corner with no edge grain of forms exposed to the face of the concrete. Construct exposed corners to produce smooth, solid, unbroken lines.

### 3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Sized and placed where indicated on the Drawings.
- C. The complete work shall be in place and approved a minimum of one working day prior to placing of concrete.
- D. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- E. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

- F. Wire Mesh: Panels shall be spliced not less than two mesh openings, and shall be in placed one working day prior to placing concrete. While the concrete is still plastic, the mesh shall be carefully lifted into position as specified on the Drawings.
- G. Install welded wire reinforcement in lengths as long as practicable. Flat sheets, not rolls unless otherwise accepted by Design Consultant. 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.
- H. Reinforcing Bars: Bars shall be place in accordance with the size and spacing shown of the Drawings. The bars shall be firmly and securely wired together and held in place with concrete or metal chairs. The complete work shall be in place and approve a minimum of one working day prior to placing of concrete.
- I. 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 2-inch overlap to adjacent mats.
- J. Dowel: Speed Dowels, or equal (no known equal). Before reinforcing steel is placed on top of or adjacent to forms that have been sealed, the surface sealer shall be wiped off so that none may be tracked over or come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.

### 3.5 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.
  - 2. Locate as indicated on the Drawings.
- B. Construction Joints or Expansion 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. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
  - 2. Provide tie bars at sides of pavement strips where indicated.
  - 3. Dowels: Provide steel dowels across construction joints to reduce differential movement across the joint. Utilize steel dowels based upon the following:
    - a. 6-inch Thick Pavement:  
Diameter: ½-inch.  
Length: 24-inch.

On-center Spacing: Per reinforcing schedule.

b. 4-inch Thick Pavement:

Diameter: ½-inch.

Length: 24-inch.

On-center Spacing: Per reinforcing schedule.

4. To assist in correct alignment of steel dowels along construction joints use Speed Dowel™ plastic dowel alignment sleeves:

a. Insure that wood edge forms are true to line and grade prior to installing plastic dowel alignment sleeves.

b. Install plastic dowel sleeves on wood forms at the specified on-center dowel spacing, centered between top and bottom of wood form.

C. Expansion/ 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. Expansion material shall be placed at the appropriate elevation to achieve the depth of the sealant indicated on the Drawings. The top of the finished sealant shall be between 1/8" and 1/4" below the finished surface.
2. Locate expansion joints at intervals as indicated on drawings, unless otherwise indicated.
3. Extend joint fillers full width and depth of joint.
4. Terminate joint filler, as indicated on drawings, below finished surface if joint sealant is indicated.
5. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
6. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
7. 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. Contraction Joints or Scorelines: 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 as indicated in the Drawings.

1. Sawed Joints: Form contraction joints with power saws equipped with shatter-proof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
2. Provide machine-sawn Contraction joints as soon as concrete has sufficient strength to support sawing equipment.
3. Joints shall meet the size and depth indicated on the drawings. Joints shall be true to lines and shapes shown on the Drawings and not vary from true. Grooves

shall be smooth and uniform.

4. The completed groove at the finished surface shall not vary more than 1/32" of the width indicated.

- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

### 3.6 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. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- D. Do not add water to concrete during delivery or at Project site.
- E. Do not add water to fresh concrete after testing.
- 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 according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  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. Screed pavement surfaces with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart 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 or spreading surface treatments.
- J. 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.
- K. 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 low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
- L. Hot-Weather Placement: Comply with ACI 301 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. 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.
- M. At the end of a work day, or when more than two hours may elapse between concrete pours, installation shall terminate at an expansion joint or other transition as shown on the Drawings.
- N. Removal of Forms: The supporting forms shall not be disturbed until the concrete has hardened sufficiently to permit their removal with safety.

### 3.7 CONCRETE FINISHING

- A. General: Paving finishes to match approved mock-up finishes.

### 3.8 WASH SAND FINISH:

- A. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down coarse aggregate, filling each hole and leveling surface to a true and even surface
- B. Finish paving to match approved mock-up and have a uniform color and texture over the entire area.
- C. Surfaces shall be free of ruts, grooves, dimples.
- D. Edges shall be crisp and true to lines, and have finishes consistent with the field area. Float surfaces to required surfaces and planes. Finish to etch surface so that fines are exposed (no aggregate exposed.)
- E. Ensure that paving surfaces receiving the finish are hand-troweled before final concrete set.

- F. Match approved paving sample. It is recommended that a 2-foot x 2-foot test sample be poured from the same field mix and finished as same for each finish specified.
- G. Sand Wash Finishes:
  - 1. Light:
    - a. Light finish paving to match approved mock-up.
    - b. Thoroughly clean field pour and allow to dry.
    - c. Check for “hard spots”.
  - 2. Heavy:
    - a. Follow steps as outlined above for a light finish.

### 3.9 EXPOSED AGGREGATE:

- A. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down coarse aggregate, filling each hole and leveling surface to a true and even surface
- B. Exposed aggregate finish paving to match approved mock-up and have a uniform color and texture over the entire area.
- C. Surfaces shall be free of ruts, grooves, dimples.
- D. Edges shall be crisp and true to lines, and have finishes consistent with the field area. Float surfaces to required surfaces and planes. Finish to etch surface so that fines are exposed (no aggregate exposed.)
- E. Immediately after concrete has been screeded and darbied, apply specified surface aggregate (if specified in the Drawings), evenly over entire surface, allowing no voids in coverage.
- F. After seeding aggregate (if specified in the Drawings), embed the aggregate by hand-floating, so that top of aggregate is just below the surface.
- G. As soon as the concrete has achieved a firm set, begin simultaneously brushing and hosting the surface with water so as to achieve a clean, uniform surface with no aggregate exposed more than 1/8-inch.
- H. Do not dislodge or unevenly expose the surface so as to take on a “bald” spot appearance. Doing so may lead to paving rejection.

### 3.10 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Edge forms and intermediate screed strips shall be set accurately to produce the elevations and contours in the finished surface.

- C. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down coarse aggregate, filling each hole and leveling surface to a true and even surface.

### 3.11 SANDBLAST FINISHES:

- A. Finishes shall match the approved mock-up panels, and have a uniform color and texture over the entire area. Surfaces shall be free of ruts, grooves, dimples, or swirl marks resulting from the sandblast operations. Edges shall be crisp and true to lines, and have finishes consistent with the field.
- B. Sandblast finish paving to match approved mock-up.
- C. Perform sandblasting in as continuous an operation as possible, utilizing same work crew to maintain finish continuity.
- D. Provide sandblasting to a finish as indicated on Drawings.
- E. Depth of Etch: Use an abrasive sand of the required gradation and grit to expose paving surface to achieve specified etch:
  - 1. Light Sand Blast: Approximately 1/32 to 3/32-inches deep.
  - 2. Medium Sand Blast: Approximately 1/16 to 1/8-inches deep.
  - 3. Heavy Sand Blast: Approximately 3/32 to 5/32-inches deep.
- F. Carefully blast corners and edges of paving using appropriate backup boards, in order to maintain a uniform corner or edge finish as well as prevent blast damage to adjacent surfaces and landscaping.
- G. Use same nozzle, nozzle pressure and blasting technique as used to prepare initial paving mock-ups. Exercise care to provide even and consistent strokes with air nozzle to minimize pockmarking of paving surface.
- H. Cleanup and remove expended sand particles, concrete dust, loose aggregate, and other work-related debris at end of each day's blasting operations.

### 3.12 SEEDED WASHED AGGREGATE FINISH:

- A. Finished surface shall match the approved mock-up panel in color and texture. Surfaces shall be free of ruts, grooves, dimples and have a uniform distribution of exposed coarse and fine aggregate over the entire surface area. Edges shall be crisp and true to lines, and have a finish consistent with the field area.

### 3.13 BROOM



- A. After final floating, apply a hand-trowel finish followed by a broom finish to concrete.
- B. Medium-to-Fine-Textured Broom Finish:
  - 1. Draw a soft bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
- C. Medium-to-Coarse-Textured Broom Finish:
  - 1. Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

#### 3.14 QUARRY STONE FINISHES:

- A. Finished surface shall match the approved mock-up panel in color and texture. Surfaces shall be free of ruts, grooves, dimples and have a uniform distribution of exposed coarse and fine aggregate over the entire surface area. Edges shall be crisp and true to lines, and have a finish consistent with the field area.
  - 1. Light:
    - a. Light Quarry Stone finish paving to match approved mock-up.
  - 2. Medium:
    - a. Medium Quarry Stone finish paving to match approved mock-up.
  - 3. Heavy:
    - a. Heavy Quarry Stone finish paving to match approved mock-up.

#### 3.15 CONCRETE PROTECTION AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 305R for hot weather and ACI 306R for cold weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture retaining cover, curing compound, or combination of following:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with following materials:
    - a. Water.
    - b. Continuous water fog spray.

- c. Absorptive cover, water saturated, kept continuously wet.
- 2. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
- 3. Curing Compound:
  - a. Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions.
  - b. Recoat areas subjected to heavy rainfall within three hours of initial application.
  - c. Maintain continuity of coating and repair damage during curing period.
- E. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- F. Comply with ACI 306.1 for cold-weather protection.
- G. Protection and Curing: Provide and apply a sheet curing material that conforms to ASTM C 171, Standard Specifications for Sheet Material Curing Concrete. Protect concrete from defacement. Defaced concrete shall be replaced between expansion joints at no additional expense to the City.
- H. 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 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.
- I. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- J. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating and repair damage during curing period.
  - 1. Cure integrally colored concrete with a pigmented curing compound.
  - 2. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented curing compound.
- K. Sealers: Prepare the finished surface and apply the penetrating sealer as recommended by the manufacturer.
- L. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing

period.

- M. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over pavement edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

### 3.16 SEALER

- A. Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90-degrees to the direction of the first coat using same application methods and rates.
  - 1. Begin sealing dry surface no sooner than 14 days after concrete placement or per the manufacturer's recommendations.
  - 2. Allow stained concrete surfaces to dry before applying sealer.
- B. Mix slip-resistant additive thoroughly in sealer before application according to manufacturer's written instructions. Stir sealer occasionally during application to joint sealant.
- C. Prior to applying the sealant, the joints shall be cleaned of all mortar, laitance, scale, dirt, dust, oil, curing compound, and other foreign materials. The joints and adjacent surfaces shall be dry and where called for by the manufacturer, prepared with a primer. The joints shall be filled from bottom to top without voids. Adjoining surfaces shall be protected during the sealing operations and stains, marks, or damage resulting from the sealant operations shall be corrected.

### 3.17 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
  - 1. Elevation: 1/4 inch.
  - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
  - 4. Lateral Alignment and Spacing of Dowels: 1 inch.
  - 5. Vertical Alignment of Dowels: 1/4 inch.
  - 6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
  - 7. Joint Spacing: 3 inches.
  - 8. Contraction Joint Depth: Plus 1/4 inch, no minus.
  - 9. Joint Width: Plus 1/8 inch, no minus.

### 3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
- C. Testing Frequency: Obtain at least 1 composite sample for each 5000 sq. ft. or fraction thereof of each concrete mix placed each day.
  - 1. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
- D. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
- E. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
- F. Concrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and 1 test for each composite sample.
- G. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- H. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days for information and 2 specimens at 28 days.
  - 1. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- I. Strength of each concrete mix will be satisfactory if every average of three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- J. Test results shall be reported in writing to Design Consultant, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- K. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Design Consultant but will not be used as sole basis for approval or rejection of concrete.
- L. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Design Consultant.

- M. Remove and replace decorative cement concrete pavement where test results indicate that it does not comply with specified requirements.
- N. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.19 REPAIRS AND PROTECTION

- A. Remove and replace decorative cement concrete pavement that is broken, damaged, or does not comply with requirements in this Section in complete sections from joint to joint, unless otherwise approved by Design Consultant.
- B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.
- 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 decorative cement concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep decorative cement concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 17 - LITHOCRETE® ARCHITECTURAL CONCRETE PAVING

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Include services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings and specified herein as required to properly complete the work in this contract.
- C. Related Sections:
  - 1. Section 01 10 10 - Sustainable Design Requirements.
  - 2. Division 03 Section "Cast-In-Place Concrete" for formwork; material, fabrication, and installation requirements for steel reinforcement; and field quality control.
  - 3. Division 03 Section "Landscape Architectural Concrete" for formwork; material, fabrication, and installation requirements for steel reinforcement; and field quality control.
  - 4. Division 05 Section "Pipe and Tube Railings" for fabrication and installation requirements for pipe and tube railings.
  - 5. Division 31 Section "Site Clearing" for removal limits of trees, shrubs, and other plantings affected by new construction.
  - 6. Division 31 Section "Earth Moving" for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
  - 7. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in contraction and other joints in cast-in-place Landscape Architectural concrete.
  - 8. Division 32 Section "Plants" and "Turf and Grasses" for coordination with adjacent planting areas.
  - 9. Division 32 Section "Planting Irrigation" for coordination with adjacent irrigation systems.
  - 10. Division 32 Section "Pavement Joint Sealants" for joint sealants within decorative cement concrete pavement and at isolation joints of decorative cement concrete pavement with adjacent construction.
  - 11. Division 32 Section "Decorative Concrete Paving"
  - 12. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.
- D. Work included in this Section:
  - 1. Installation of sand subbase

2. Installation of formwork, jointing and reinforcing.
3. Installation of Lithocrete architectural concrete installed under U.S. Patents #4,748,788 and #6,016,635 per Shaw and Sons (949) 642-0660. Contact Paul Taylor.

## 1.2 REFERENCES AND STANDARDS

- A. American Concrete Institute (ACI) - 2001 Edition.
- B. American Society of Testing Materials (ASTM).
- C. Lithocrete Personnel Training Manual, latest revision February 1998.
- D. Portland Cement Association - "Design and Control of Concrete Mixtures", 13th Edition.
- E. Concrete Reinforcing Steel Institute's recommended practice "Placing Reinforcing Bars" for placing and supporting reinforcement.
- F. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

## 1.3 QUALITY ASSURANCE

- A. Finish Samples: Finish samples for finished are in City possession and are available for inspection. Finish samples shall remain as City property.
  1. Prior to paving installation, provide one 4-foot x 4-foot x 4-inch mock-up of each Lithocrete paving type specified on Drawings, based on finish samples.
  2. Ensure that at least one of the mock-ups contain each joint type indicated on Drawings, i.e. construction, contraction, and isolation. Install caulking if specified on Drawings.
  3. Approved mock-ups will be standard for future paving review and approval.
  4. Remove mock-ups from site upon completion of Work.
- B. Testing:
  1. Testing Agency: Design Consultant may designate a qualified testing agency. Testing personnel to meet ASTM E329 requirements.
  2. Analyses: Samples of materials may be taken and analyzed for conformity to this Section. Furnish samples to design Consultant as requested.
  3. Cost of Testing: Contractor shall pay costs associated with testing of materials not conforming to this Section.
- C. Requirements of Regulatory Agencies: Federal, State and local laws and regulations governing this Work are hereby incorporated into and made part of this Section. When this Section calls for certain materials, workmanship, or a level of construction that exceeds the level of Federal, State or local requirements, provisions of this Section take precedence.
- D. Inspections and Permits: Provide for inspections and permits required by Federal, State

and Local authorities in furnishing, transporting, and installing materials.

E. Allowable Tolerances:

1. Concrete to be installed true to line and grade and as indicated on Drawings. Ensure that finish surface of concrete paving does not vary more than 1/4-inch per foot except at grade breaks. No "birdbaths" or other surface irregularities will be permitted. Correct identified irregularities to the satisfaction of the Design Consultant.
2. Exercise care in placing, forming and doweling, lacing reinforcing, mixing and placing concrete to obtain smooth and even surfaces.
3. Be responsible for providing proper drainage without "birdbaths" on paving surfaces. Discrepancies or omissions on Drawings, or on-site conditions, which prevent proper drainage, should be brought to Design Consultant's attention for direction prior to beginning work.

F. Contractor's Qualifications: Provide evidence to indicate successful experience in providing Lithocrete concrete paving similar to that specified herein and demonstrate successful experience through past project documentation and references.

1. Licensed Experience: Minimum 3 years experience as a licensed Lithocrete installer with combined installation of not less than 200,000 of Lithocrete paving.
2. Demonstration of Experience : Provide a minimum of three local projects within a 100 mile radius of project site installed with Lithocrete architectural concrete paving, complete with reference list containing following contact people and current telephone numbers:
  - 1) Owner.
  - 2) Architect
  - 3) Design Consultant
  - 4) Property Maintenance Company
3. Supervision: Perform placement and finishing of concrete work under supervision of a person having a minimum of 3 years experience in placement and finishing of products specified herein.
4. Submit qualification to Design Consultant for information purposes. Submit a resume of Project Manager and Superintendent who will be overseeing the Work.

G. Ready-Mix Concrete Batch Plant Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

H. Slip Resistance: Provide a finish surface slip resistance coefficient of friction equal or greater than finish samples (test results available).

I. Material selection: Select materials that have the highest possible recycled content while still meeting performance criteria. Select materials from local manufacturers wherever possible.

1.4 SUBMITTALS



- A. Product Data: Submit no later than 10 days after contract award, one booklet containing a list of products specified in this Section. Include product "cut sheets" used under this Section to include but not be limited to the following - integral color, plastic dowel sleeves, curing agents, and sealer.
- B. Certificates:
1. Provide certified mill test reports as to chemical and physical properties of reinforcing bars furnished.
    - a. Provide submittals to document material selection as follows:
    - b. Complete Materials Cost Tracking Sheet.
    - c. Data from manufacturer to certify recycled content, manufacture location and harvest location (i.e. cut sheets and/or manufacturer certification letters).
  2. Provide submittals to document material selection:
    - a. Complete Materials Cost Tracking Sheet for concrete.
    - b. Data from manufacturer/batch plant to certify fly ash content in concrete mix.
- C. Statement of Mix Design: Submit one copy to the Statement of Mix Design prepared by batch plant servicing Project for each concrete type delivered to Project. Statement of Mix Design to contain following information:
1. Name, address, and telephone number of batch plant preparing statement of mix design.
  2. Date of Mix Design.
  3. Project location.
  4. Contractor requesting load delivery.
  5. Mix Design Number.
  6. Integral color used.
  7. Gradations for sand and aggregate.
  8. Material weights, specific gravity, and absolute volumes.
  9. Basis of testing, i.e. UBC 2605 D4 and Title 24 2604 D4.
  10. Water /cement ratio.
  11. Admixtures.
  12. PSI rating at 28 days.
  13. Signature of testing laboratory manager.

14. Signed stamp from registered Project structural engineer or architect.
  15. Include the highest percentage of fly ash in concrete mix that will meet the specified performance criteria.
- D. Extra Stock:
1. Provide one 50-pound sealed bag of each Lithocrete aggregate installed for future repair work.
- E. Submittals shall be in accordance with section 01330.
- F. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
1. Credit MR 4.1 & 4.2, Recycled Content
  2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Store materials in a dry and protected location. Protect reinforcing steel and dowels from rusting, staining and moisture damage.
- B. Keep Lithocrete aggregates clean and dry prior to installation.

#### 1.6 PROJECT CONDITIONS

- A. Ensure that substrate conditions set to receive concrete paving are acceptable before beginning work. Do not begin work until unsatisfactory conditions have been resolved to Design Consultant and Contractor's satisfaction.
- B. Sequencing and Scheduling of Work:
  1. Other Trades Work:
    - a. Coordinate with other trades items that need to be furnished and set in place prior to beginning work. Portions of other trades work to be executed by them so as not to delay progress of Contractor's work.
    - b. Be responsible for proper installation of accessories embedded in concrete for provision of holes, vaults, and openings, necessary to execution of other trades work.
    - c. After wood forms have been placed and approved by Design Consultant, ensure that other trades have been notified and given sufficient times to complete their portion of work.
- C. Do not place concrete when subbase temperature is less than 40 degrees F, nor when surface is wet.

#### 1.7 COORDINATION

- A. Ensure that utility and irrigation sleeves, utility covers, and other surface elements are

accommodated and locations approved by Design Consultant prior to installing concrete paving.

#### 1.8 SUBSTITUTIONS

- A. No other alternative paving finishes to Lithocrete will be allowed which include but are not limited to:
  - 1. Monolithic Concrete Paving Finishes:
    - a. Exposed surface-seeded glass aggregate by means of washing or brushing ("sand finish").

#### 1.9 INSPECTION OF SITE

- A. Verify conditions at site that affect Work of this Section, and take field measurements as required. Report major discrepancies between Drawings and field dimensions to Design Consultant prior to commencing work.

#### 1.10 PROTECTION OF LITHOCRETE CONCRETE PAVING

- A. Do not permit trade equipment or vehicular traffic on finished Lithocrete paving for the duration of the project; to include but not to be limited to the following - manlifts, forklifts, skip loaders, Bobcats, generators, welders, backhoes, rolling scaffolding, pallet jacks, and scissor lifts.
- B. Do not permit pedestrian traffic on finished concrete paving within 14 days of pour.
- C. Contractor Work Access Pathways: General Contractor to provide 1/2 inch thick plywood pathways (minimum 8-feet wide) connected with Tico panel clips and 3/8" screws. Plywood to rest on 1/4" polyform sheeting or virgin milled (unstained) carpeting for protection pathways.
- D. General Contractor to be responsible for damage and related repair efforts resulting from trade damage to installed finished concrete paving.

#### 1.11 WARRANTY

- A. In addition to manufacturer's guarantees for products installed in conjunction with this section, concrete work will be warranted for one year from date of Final Acceptance by the City against defects in materials, workmanship, and damage caused by Contractor's employees.
- B.

### PART 2 - PRODUCTS

#### 2.1 FORMS

- A. Form work to be new, #2 grade Douglas Fir, free of knots, checks, bows and cracks.
- B. "Keykold" joint per Drawings.

2.2 READY MIX CONCRETE

- A. Batched, mixed and transported in accordance with ASTM C94 - "Specifications for Ready Mixed Concrete".

2.3 PORTLAND CEMENT

- A. Refer to Drawings for specific paving finishes requiring different cement types, to include Type I, II, III, or II/V cements conforming to ASTM C150.
- B. Use same brand of cement from single source throughout entire project for each paving type.
- C. Refer to Statement of Mix Design for cement type used.

2.4 FINE AGGREGATE

- A. Clean, hard, and durable washed concrete sand, conforming to ASTM C33.
- B. Use same fine aggregate from single source throughout entire project.
- C. Refer to Statement of Mix Design for fine aggregate type used.

2.5 COARSE AGGREGATE

- A. Clean, hard, and durable coarse aggregate, conforming to ASTM C33.
- B. Use same fine aggregate from single source throughout entire project.
- C. Refer to Statement of Mix Design for fine aggregate type used.

2.6 WATER

- A. Free from deleterious materials such as oils, acids, and organic matter.

2.7 LITHOCRETE AGGREGATE

- A. Refer to Drawings for specified Lithocrete glass aggregate type, size, color and distribution percentage.
- B. Use same Lithocrete glass aggregate from same source for each paving type specified throughout entire project.
- C. Keep Lithocrete glass aggregates clean and dry prior to broadcasting.

2.8 ADMIXTURES

- A. Integral Coloring Admixture (dry pigment): Refer to Drawings for color type and manufacturer.
  - 1. Acceptable Manufacturer: L.M. Scofield; (800) 800-9900.
- B. Set Retarders: Conforming to ASTM C494, Type B and D.
  - 1. Acceptable Manufacturers:

- a. Grace Construction Products; Daratard 17 Set Retarder (800) 433-0020
  - b. Master Builders, Inc.; Pozzoloth Retarder, (800) 628-9990
- C. Shrinkage Reducing Admixtures: Conforming to ASTM C157.
  - 1. Acceptable Manufacturers:
    - a. Grace Construction Products; Eclipse, (800) 433-0020
- D. Air Enhancement Admixtures: Conforming to ASTM C260.
  - 1. Acceptable Manufacturers:
    - a. Grace Construction Products; Daravair, (800) 433-0020
    - b. Master Builders, Inc.; Micro-Air, (800) 628-9990
- E. Water Reducing Admixtures: Conforming to ASTM C494, Type A.
  - 1. Acceptable Manufacturers:
    - a. Grace Construction Products; WRDA, (800) 433-0020
    - b. Master Builders, Inc.; Micro-Air, (800) 628-9990
- F. Fly Ash: Conforming to ASTM C 618 - Type F. To be used only in Lithocrete aggregate paving finishes. Combined weight of fly ash conforming to ASTM C618 to not exceed 25% of total weight of cementitious materials.

## 2.9 REINFORCING

- A. Reinforcing Steel: Conforming to ASTM A615, clean and free of rust, dirt, grease or oils.
- B. Tie Wire: 16 1/2 gauge annealed steel wire conforming to ASTM A82, clean, and free of rust, dirt, grease, and oils.
- C. Supports for Reinforcement:
  - 1. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars in place.
- D. Polypropylene Fiber Reinforcement: 100% virgin multifilament polypropylene fibers, complying with ASTM C1116 - Type III.
  - 1. Acceptable Manufacturers:
    - a. Fibermesh; Fibermix Stealth - 1/4" long (423) 892-8080
    - b. Grace Construction Products; MicroFiber, (800) 433-0020
  - 2. Application Rate: 1/2 lb./cy of mix.

## 2.10 JOINT MATERIALS

### A. Construction Joints:

1. Steel Dowels: 1/2-inch-diameter smooth steel bars, free of dirt, grease, and oils.
2. Plastic Dowel Sleeves: Encase 50 percent of each dowel in a Speed Dowel plastic sleeve to allow parallel lateral movement of each dowel. Greenstreak, (800) 325-9504.

### B. Isolation Joints:

1. See Drawings

### C. Other Joints:

1. Refer to Section 02520

## 2.11 CURING MATERIALS

### A. Absorptive Cover. Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

### B. Moisture Retaining Cover: One of the following complying with ASTM C 171:

1. Water proof paper
2. Polyethylene film.
3. White Burlap-polyethylene sheeting.

### C. Clear, Waterborne Membrane-Forming Curing Compounds:

1. Provide curing materials that have a maximum volatile organic compound (VOC) rating of 350 g/l.

### D. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

#### 1. Clear, Waterborne Membrane-Forming Curing Compounds Acceptable Manufacturers:

- a. Anti-Hydor Company; Clear Cure Water Base.
- b. The Burke Company; Spartan Cote WB.
- c. Cormix Construction Chemicals; Sealco VOC.

#### 2. Acceptable Evaporation Control Manufacturers:

- a. Conspec Marketing and MFG, Company; Aquafilm.
- b. Euclid Chemical Company; Eucobar.
- c. L&M Construction Chemicals; E-Con.

### **PART 3 - EXECUTION**

#### **3.1 SUBGRADE PREPARATION**

- A. Subgrade to meet requirements of project's soils report.
- B. Verify that paving subgrade consists of a minimum of 4-inches of compacted washed concrete sand, passes less than 7% through a #200 sieve, and is compacted to at least 95% of the materials ASTM D 1557 maximum dry density for it's full depth.
- C. Verify that paving subgrade extends 1-foot beyond the outside edge of paving of curbing and has a positive outfall for trapped water.
- D. Ensure that utilities, including irrigation lines are buried and compacted below bottom of sand subbase.
- E. Screed sand to a smooth and level plane.
- F. Proof-roll prepared sand subbase to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive concrete paving.
- G. Remove loose material from compacted sand base prior to placing concrete.
- H. Provide necessary chairs or supports, and maintain position of reinforcing bars.
- I. Dampen sand subbase prior to placing concrete, ensure that no standing water exists.

#### **3.2 FORM WORK**

- A. Be responsible for design and engineering of formwork as well as it's construction.
- B. Construct forms accurately to dimensions, plumb and true to line grade. Set formwork tight and braced so as to maintain position and shape during placement of reinforcing steel and concrete.
- C. Carefully examine Drawings and provide necessary recesses and openings of proper sizes and shapes. Secure anchor plates, inserts, and other items to be embedded in concrete accurately so that they will not be displaced during concrete placement.
- D. Ensure that form lumbar is new #2 or better grade wood, free of splits, knotholes, and true to line both horizontally and vertically.
- E. Set formwork where both horizontal and vertical planes are straight and plumb.
- F. Construct forms in such a manner that construction joints occur at locations indicated on Drawings. Do not exceed 20-feet by 20-feet in formed construction area.
- G. Observe formwork carefully and check for alignment and level as work proceeds. Perform adjustments and add additional staking, if necessary.
- H. Obtain Design Consultant 'sapproval of formwork before placing concrete.
- I. Wets side of wood in contact with concrete prior to pour.

- J. Allow formwork to remain in place long enough for concrete to set properly. Do not remove supporting forms until concrete has sufficient strength to support its own weight without deflection.
- K. Remove forms when appropriate and discard offsite.

### 3.3 REINFORCEMENT

- A. Place reinforcement as indicated on Drawings.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and 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 over reinforcement.
- D. Wet to cool steel bars prior to placement of concrete.

### 3.4 DESIGN OF MIXES AND PROPORTIONING

- A. Proportion and mix of cement, aggregate, admixture and water to attain required plasticity and strength in accordance with current edition of ACI Manual of Concrete Practice and PCA " Design and Control of Concrete Mixtures".
- B. Concrete Mixtures to be designed by an approved commercial testing laboratory, using approved materials to obtain specified minimum compressive strength.
- C. Concrete Mix Criteria:
  - 1. Slump:
    - a. Maximum: 5-inches
    - b. Minimum: 3-inches
  - 2. PSI Rating (minimums):
    - a. At 7 days: minimum of 3,000.
    - b. At 28 days; minimum of 4,500.
  - 3. Cement:
    - a. Type: as noted on Drawings
    - b. Quantity per yard of mix :
      - 1. Minimum: 6 1/2 sacks
      - 2. Maximum: 7 sacks
  - 4. Water / cement ratio: 0.62 -0.67
  - 5. Fine aggregate (washed concrete sand): 70% of total



6. Coarse aggregate: 30% of total
7. Admixtures:
  - a. Air entrainment: Do not exceed 2%.
  - b. Shrinkage Reducing: Do not exceed 2% by weight of cement.
8. Fly Ash: Use only when seeding glass Lithocrete aggregates.
9. Accelerators: Do not use corrosive accelerators such as calcium chloride.
10. Concrete Delivery: Do not use concrete loads exceeding 90 minutes from the time of batching.
11. Ensure that batch plant guarantees single source supply for cement, fine aggregate, and coarse aggregate for entire length of project.

### 3.5 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork, installation of their steel, and items to be embedded or cast in. Notify other trades to facilitate installation of their work.
- B. Moisten sand subbase to provide a uniform dampened condition at the time it is placed. Do not place concrete around manholes and other utility structures until they are at the required finish elevation and alignment.
- C. Comply with requirements and with ACI 304R for measuring, transporting and placing concrete.
- D. Deposit and spread concrete in a continuous operation between construction joints.
- E. Consolidate concrete by mechanical vibrating equipment supplemented by hand spreading, rodding, or ramping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
  1. Consolidate concrete along face of forms with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement or side forms. Use only square faced shovels for hand spreading and consolidation. Prevent dislocating reinforcing and dowels.
- F. Screed paved surfaces with a straight edge and strike off. Use bull floats to form a smooth surface plane before excess moisture or bleed appears on surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- G. Hot weather Placement: Place concrete complying with ACI 305R when hot weather conditions exist.
  1. Cool ingredients before mixing to maintain concrete temperature at time of placement 90 degrees F and below. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.

2. Cover reinforcing steel with water soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog Spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, or soft dry areas.

### 3.6 LITHOCRETE AGGREGATE APPLICATION

- A. Broadcasting of Lithocrete glass aggregates to be performed only through a licensed Lithocrete installer.
- B. Lithocrete process of embedding surface-seeded aggregates incorporates, but is not limited to the following propriety products:
  1. Lithocrete conditioner
  2. Lithocrete Etch-Retarder
  3. Lithocrete paving surface sealer.

### 3.7 JOINTING

- A. Refer to ACI 302 "guide for Concrete Floor and Slab Construction" for work under this section.
- B. Contraction Joint:
  1. Sawcut contraction and construction joints in locations as indicated on Drawings.
  2. Perform jointing with a new diamond tip circular saw.
  3. Joint Width: See Drawings.
  4. Sawcut Depth: See Drawings
  5. Sawcut joints in a straight line with no overcutting at intersections.
  6. Use a hand grinder with 4 inch diamond blade to sawcut up to vertical edges such as walls, steps, curbs, and columns. Do not overcut into vertical surfaces.
- C. Doweled Construction joints; Construct doweled construction joints where paving operations are stopped for more than 1/2 hour, end of day pours, and adjacent differing pavers finishes.
  1. Steel Dowels:
    - a. Provide steel dowels across construction joints to reduce differential movement across the joint. Utilize steel dowels based upon the following:
      1. 7-inch thick Pavement:
        - i. Diameter: 3/4inch
        - ii. Length: 18 inches

iii. On Center Spacing: per Drawings.

- b. To assist in correct alignment of steel dowels along construction joints, use SpeedDowel plastic dowel alignment sleeves.
  - 1. Ensure that wood edge forms are true to line and grade prior to installing plastic dowel alignment sleeves.
  - 2. Install plastic dowel sleeves on wood forms at the specified on center dowel spacing, centered between top and bottom of wood form.
- 2. Do not continue tie reinforcement through sides of strip paving.
- 3. Use a bond-breaking agent on cured concrete edges that will be joined with fresh concrete.
- 4. Immediately before new concrete is placed, wet construction joint and remove standing water.
- 5. Tool edges of construction joint to match decorative field jointing.
- 6. Joint width: Per drawings.
- 7. Sawcut joints in a straight line with no overcutting.
- 8. Use a handgrinder with a 4 inch diamond blade to sawcut up to vertical edges such as walls, steps, curbs and columns. Do not over cut.
- 9. Do not continue reinforcement through adjacent concrete pour panels.

D. Isolation Joints:

Install isolation joints and caulking per drawings.

3.8 PROTECTION

- A. Protect fresh placed concrete from premature drying and excessive cold or hot temp. Comply with the recommendations of ACI 305R for hot weather and ACI 306R for cold weather protection during curing.
- B. Keep Pedestrians and vehicles off finished slabs as indicated under part 1 of this section.

3.9 CURING

- A. Protect fresh placed concrete from premature drying and cold or hot temperatures. Comply with the recommendations of ACI 305R for hot and ACI 306R for cold, for protection during curing.
- B. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- C. Curing Methods: Cure concrete by moisture curing, moisture retaining cover curing, curing compound, or a combination of the following:

1. Moisture Curing: Keep surfaces moist for not less than 7 days with:
  - a. water
  - b. Water fog spray
  - c. Absorptive cover, water satirized always kept wet.
2. Cover concrete surfaces with a 12 inch lap over adjacent absorptive covers.
3. Curing Compound:
  - a. Apply uniformly in continuous operation by power spray or roller according to Manufacturers instructions.
  - b. Recoat areas subjected to heavy rainfall within 3 hours after initial application.
  - c. Maintain continuity of coating and repair damage during curing periods.

### 3.10 DAMAGED CONCRETE

- A. Remove and replace concrete paving that is broken, damaged, defective, or does not meet the requirements of this Section. Damaged paving to be replaced at Contractor's expense when damage is done by direct negligence of Contractor.

### 3.11 SEALING

- A. After paving is cured, seal paving with a minimum of three light coats of "Lithoseal" paving sealer.
- B. Follow Lithoseal paving sealer directions when applying this product.
- C. Additional sealers to Lithoseal will not be allowed with out approval by Design Consultant and Contractor.

### 3.12 CLEANUP

- A. Keep work area clean, neat and orderly throughout the duration of the project.
- B. Prior to Final Acceptance review by Design Consultant, cleanup and remove deleterious materials and debris from entire work area.
- C. At completion of Work, remove concrete stains caused from Contractor's work on adjacent paving, walls, columns, railing posts, light fixtures, plant materials, to satisfaction of Design Consultant.
- D. Dispose of site-generated waste in accordance with the accepted Contractor's Construction Waste Management Plan.
- E. Comply with the Stormwater Pollution Prevention Plan developed for the Project.
- F. Comply with the Erosion Control Plan for the Project.

END OF SECTION

## SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Expansion and contraction joints within cement concrete pavement.
  - 2. Joints between cement concrete and asphalt pavement.
- B. Related Sections include the following:
  - 1. Section 01 10 10 Sustainable Design Requirements
  - 2. Division 32 Section "Decorative Concrete Paving" for constructing joints in concrete pavement.
  - 3. Division 33 Section "Landscape Architectural Concrete" for constructing joints at concrete walls and other appurtenances.
  - 4. Division 33 Section "Lithocrete Architectural Concrete Paving" for constructing joints in concrete paving
  - 5. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

#### 1.3 REFERENCES

- A. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

#### 1.4 SUBMITTALS

- A. Comply with Section 13 33 00 Submittal Procedures and Section 01 10 10 - Sustainable Design Requirements.
- B. Product Data: For each joint-sealant product indicated.
- C. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- E. Qualification Data: For Contrator.

- F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.
- H. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.5 QUALITY ASSURANCE

- A. Contractor Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - 2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
  - 5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
- D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the [commencement of] the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

#### 1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
  2. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg.
  3. When joint substrates are wet or covered with frost.
  4. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  5. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

#### 2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Design Consultant from manufacturer's full range.

## 2.3 COLD-APPLIED JOINT SEALANTS

- A. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- B. One part moisture curing polyurethane sealant designed for caulking applications of exterior horizontal joints. Self-leveling and compatible for uses with the expansion material.
  - 1. Products:
    - a. Sonneborn, Div. of ChemRex, Inc.; Sonomeric 1.
    - b. Polytite
    - c. Tremco

## 2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

## 2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Contractor present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.



### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of backer materials.
  - 2. Do not stretch, twist, puncture, or tear backer materials.
  - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses provided for each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealants from surfaces adjacent to joint.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

#### 3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

#### 3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 32 14 45 - POROUS PAVING

**PART 1 - GENERAL**

1.1 SUMMARY

- A. The Work to be completed under this contract includes the furnishing of labor, materials and equipment necessary for construction of the proposed improvements in conformance with the plans and specifications.

A. Section includes:

1. Porous paving systems.
  - a. Concrete.

B. Related Work Specified Elsewhere:

1. Section 01 10 10 - Sustainable Design Requirements.
2. List below only products and construction that the reader might expect to find in this Section but are specified elsewhere.
3. Division 03 Section "Cast-In-Place Concrete" for formwork; material, fabrication, and installation requirements for steel reinforcement; and field quality control.
4. Division 32 Section "Landscape Architectural Concrete Paving" for Landscape Architectural concrete pavement and flatwork finishes.
5. Division 05 Section "Metal Fabrications" for fabrication and installation requirements for handrails.
6. Division 31 Section "Site Clearing" for removal limits of trees, shrubs, and other plantings affected by new construction.
7. Division 31 Section "Earth Moving" for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
8. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in contraction and other joints in cast-in-place Landscape Architectural concrete.
9. Division 32 Section "Decorative Concrete Paving" for Landscape Architectural concrete pavement and flatwork finishes.
10. Division 32 Section "Lithocrete Architectural Concrete Paving" for Landscape Architectural concrete pavement and flatwork finishes.
11. Division 32 Section "Plants" and "Turf and Grasses" for coordination with adjacent planting areas.
12. Division 32 Section "Planting Irrigation" for coordination with adjacent irrigation systems.

13. Division 33 Section “Subdrainage” for drainage under permeable paving
14. Section 01 81 13, “SUSTAINABLE DESIGN REQUIREMENTS”: LEED Requirements.

## 1.2 REFERENCES AND STANDARDS

- A. Conform to the following codes and standards:
- B. American Society for Testing and Materials
  1. ASTM C29 “Test for Unit Weight and Voids in Aggregate”
  2. ASTM C33 “Specification for Concrete Aggregates”
  3. ASTM C42 “Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.”
  4. ASTM C117 “Test Method for Material Finer than 75 microns (No. 200) Sieve in Mineral Aggregates by Washing.”
  5. ASTM C138 “Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.”
  6. ASTM C140 “Methods of Sampling and Testing Concrete Masonry Units.”
  7. ASTM C150 “Specifications for Portland Cement” (Types I and II only)
  8. ASTM C172 “Practice for Sampling Fresh Concrete”
  9. ASTM C260 “Specification for Air-Entraining Admixtures for Concrete”
  10. ASTM C494 “Specification for Chemical Admixtures for Concrete”
  11. ASTM C595 “Specification for Blended Hydraulic Cements” (Types IP or IS only)
  12. ASTM 989 “Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.”
  13. ASTM C1077 “Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and criteria for Laboratory Evaluation.”
  14. ASTM D448 “Specification for Standard Sizes of Coarse Aggregate for Highway Construction.”
  15. ASTM D1557 “Tests for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10 Pound Rammer and 18-inch Drop.”
  16. ASTM E329 “Standard Recommended Practice for Inspection and testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction.”
- C. American Association of State Highway and Transportation Officials (AASHTO)
  1. AASHTO T-180 “Moisture-Density Relations of Soils Using a 101 lb (45.4 kg) Rammer and an 18” (457 mm) Drop.”
- D. Concrete installer to have 5 or more STF porous paving projects installed, totaling at least 100,000 square feet.
- E. Provide a list of projects (5) with the address of the installation, the date of the installation, the point of contact for the project and their phone number.
- F. Provide 2 photos of each project listed above representing the project/installation.
- G. Concrete company to have been in business 10 years or more. Provide three references with phone numbers.
- H. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

1.3 CONTRACTOR

- A. The product and work shall be supplied by a contractor having experience with Porous Paving installation. Provide Pervious Concrete Contractor Certification from the National Ready Mixed Concrete Association.

1.4 QUALITY ASSURANCE

- A. Special Equipment: Some special equipment (compacting roller; misters, etc.) specific to porous concrete placement will need to be purchased or built by the placing Contractor.
- B. Test Panels: Contractor is to place, joint and cure one test panel, to be a minimum of 225 square feet at the required project thickness to demonstrate to the Engineer's and Owner's satisfaction that satisfactory pavement compaction and finish can be installed at the site location.
  - 1. Test panels may be placed at the site location. Test panels shall be evaluated for thickness, compaction and porosity.
  - 2. If the test panels are found to be insufficiently porous or insufficiently compacted, the test panel shall be removed at the Contractor's expense and disposed of in an approved landfill.
  - 3. If test panels are found to be satisfactory, they can be left in place and included in the completed work.
  - 4. Determination of thickness, porosity and compaction shall be determined by an inspector of choice of the Owner.
  - 5. Should the Contractor wish to dispute findings of inspector, acceptability shall be determined at Contractor's expense by achieving: compacted thickness according to ASTM C42 of no less than 1/4" of specified thickness, void structure of 10% minimum when tested in accordance with ASTM C140, and unit weight within +/- 5 pcf of the design unit weight when tested in accordance with ASTM C140 paragraph 6.3.
- C. Contractor Damage/Repair Mock-Ups: Provide a 2 x 2 foot "damage/repair" sample directly adjacent to each required 5 x 5-foot mock-up for each paving type specified on Project. Purpose of "damage/repair" samples are to clearly indicate Contractor's ability to repair damaged concrete to match existing, should damage occur during course of construction.
- D. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- E. Concrete Mix Design: Contractor shall furnish a proposed mix design with proportions of materials to Owner or Agent prior to commencement of work. The data shall include unit weights determined in accordance with ASTM C29 paragraph 11, jiggling procedure. Compacted void content shall be a minimum of 10%. Cement content must be sufficient to hydrate cements but not enough to generate fluidity of mix.
- F. Slip Resistance: Provide a finish surface slip resistance coefficient of friction equal or greater than 0.6 for flat surfaces and 0.8 for ramps, when tested in accordance with ASTM F 489.

1.5 SUBMITTALS

- A. In accordance with Section 01 33 00 – Shop Drawings, Samples and Product Data: Procedures for submittals.
- B. Paving Mix Designs: Provide documentation for each paving type specified on Drawings that will enable Owner's Authorized Representative's to better match replaced concrete:
  - 1. Laboratory and Cement Test Reports: Submit six (6) copies of laboratory test reports for concrete materials and a certificate with each concrete mixer truck, stating mix design, PSI, rating, slump, water and cement quantity, cement/water ration, fine and coarse aggregate and color additives.
  - 2. Cement:
    - a. Manufacturer and plant location.
    - b. Cement type, i.e. Type I, II, III, or V.
  - 3. Admixtures:
    - a. Manufacturer and plant location.
  - 4. Sand:
    - a. Source and Type.
  - 5. Aggregates:
    - a. Source and Type.
- C. Sign certification from a licensed structural engineer.
- D. Certification that Owner's Authorized Representative's mock-up has been reviewed and that materials and processes provide, will achieve intended effects indicated on Owner's Authorized Representative's mock-up.
- E. Submit specification data "Cut Sheets" for integral color, color hardener, release agent, plastic dowel sleeves, curing agents, chemical stain, expansion joint filler, reinforcement, joint sealant and clear sealer.
- F. Products; Submit one pound samples, clearly identified, for each component used to prepare each paving type, including but not limited to, cement, sand, aggregate, coloring pigment, release agents, and chemical stains.
- G. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

1.6 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01640- Product Handling and Protection: Transport, handle, store, and protect.
- B. Store materials in dry and protected locations and protect from damage.
- C. Do not change brand of cement nor source of aggregate during course of work.

1.7 SITE CONDITIONS

- A. Do not place concrete when subbase surface temperature is less than 40 degrees F, nor when surface is wet.

1.8 COORDINATION

- A. In accordance with Section 01310 – Project Coordination
- B. Ensure that irrigation sleeves, electrical conduit, food cart outlets, and other utility elements are accommodated and as-built located prior to pouring concrete.

1.9 INSPECTION OF SITE

- A. Verify conditions at site affect Work of this Section, and take field measurements as requires. Report major discrepancies between Drawings and field dimensions to Owner's Authorized Representative prior to commencing work

**PART 2 - PRODUCTS**

2.01 POROUS CONCRETE PAVING

- A. Installed system:
  - 1. Albedo: Minimum Solar Reflectance Index (SRI) of 29.
  - 2. Permeability: Minimum permeability rate 60 percent or not less than an infiltration rate of 1.1 in./hr. for a 20-year design life. Determine the field water infiltration rate of in place pervious concrete in accordance with ASTM C1701.
  - 3. Density and void content: Determine the density and void content of freshly mixed pervious concrete in accordance

2.2 PAVER RESTRAINTS

- A. Paver Edge Restraints: steel edging as indicated in the Drawings.
  - 1. Product: Permaloc Structure Edge, 3/16" x 2-1/4" high, extruded aluminum, 6063 alloy, T6 hardness, paver restraint edging for straight-line and curvilinear applications in corrugated L-shaped profile. Horizontal base shall have holes spaced 4 inches apart along its length to receive spikes.
  - 2. Manufacturer: Permaloc Corporation, Holland MI 49424, telephone (800) 356-9660 or (616) 399-9600.
  - 3. Thickness: 3/16 inch section shall have 0.210 inch thick exposed top lip.
  - 4. Length: 8 feet.
  - 5. Connection Method: Section ends shall splice together with horizontal 0.060 inch

thick x 1 inch wide x 4 inches long aluminum sliding connector.

6. Anchoring: 3/8 inch x 10 inches bright spiral steel spike. Use plastic washers if desired. For hardened surfaces (i.e. concrete, masonry, etc.) use 3/16 inch x 1-1/2 inches or longer Ardox concrete nail or drive pin fastener equal to Hilti DX 40 powder actuated pin, Ramset Trakfast Automatic Fastening System pin, or Tapcon.
7. Finish: Black DuraFlex Painted. Paint finish shall comply with AAMA 2603 for electrostatically baked on paint.

## 2.3 FORMS

- A. Form work to be new, #2 grade Douglas Fir, free of knots, checks, bows, and cracks.

## 2.4 MATERIALS AND FINISHES

### A. Porous Concrete Paving

1. Color: Per plan.
2. Aggregate: Per plan.
3. Finish: Per Plan.

- B. Locally available material having a record of satisfactory performance shall be used.

## 2.5 CEMENT:

- A. Portland Cement Type I or II conforming to ASTM C150 or Portland cement Type IP or IS, conforming to ASTM C595.
- B. Cement Content: For pavement subject to vehicular traffic loading, Portland Cement content shall not be less than 630 pounds per cubic yard.

## 2.6 AGGREGATE:

- A. Use 3/8" coarse aggregate which meets 3/8" to No. 16 per ASTM C33, or meeting 3/8" to No. 50 per ASTM D448. If other gradation of aggregate is to be used, submit data on proposed material to owner for approval. Larger aggregate sizes increase pore size but decrease workability. Aggregates which are well graded reduce porosity, and may require reduction of cementitious content to meet void specifications. Note that reductions below the minimums listed in Section 1.4, C of this document require written approval from the Engineer and Owner's Representative.
- B. Aggregate content: The volume of aggregate per cubic yard shall be equal to 27 cubic feet when calculated as a function of the unit weight determined in accordance with ASTM C29 jiggling procedure. Fine aggregate, if used, should not exceed 3 cubic feet and shall be included in the total aggregate volume.



2.7 AGGREGATE BASE:

- A. Standard Specifications Section 26-1.02B Class 2 Preamble Aggregate Base.

2.8 ADMIXTURES:

- A. Type A Water Reducing Admixtures ----- ASTM C494  
Type B Retarding ----- ASTM C494  
Type D Water Reducing/Retarding ----- ASTM C494

A hydration stabilizer will be utilized and is recommended in the design and production of porous concrete. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set. The admixture's primary function should be as a hydration stabilizer, however it must also meet the requirements of ASTM C494 Type B Retarding or type D Water Reducing/Retarding admixtures.

Air entraining agents shall comply with ASTM C260.

- B. Admixtures shall be used in accordance with the manufacturer's instructions and recommendations.

2.9 WATER:

- A. Potable or shall comply with conventional local good concrete practice.
- B. Free from deleterious materials such as oils, acids and organic matter.
- C. Mix water:
  - 1. Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate.
  - 2. Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration.
  - 3. Insufficient water results in inconsistency in the mix and poor bond strength.
- D. High water content results in the paste sealing the void system primarily at the bottom and provides a poor surface bond.

2.10 REINFORCEMENT:

- A. Fiberglass reinforced plastic (FRP) reinforcing bar shall be used to tie adjacent concrete slabs together. FRP rebar shall be of at least one-half inch diameter, uni-directionally reinforced, placed twelve inches into each slab on thirty inch or closer spacing. Steel or epoxy-coated steel shall not be used due to the exposure to moisture experienced in porous concrete.

2.11 DRAIN FABRIC

- A. Drain fabric, to be used as a barrier between different bedding materials and also act as pavement stabilizer.

### **PART 3 - EXECUTION**

#### **3.1 POROUS PAVING SYSTEM EXECUTION**

#### **3.2 SUBGRADE PREPARATION AND FORM WORK**

- A. Subgrade Material:
  - 1. The top 6" shall be composed of granular or gravelly soil that is predominantly sandy with no more than a moderate amount of silt or clay. Granular subbase may be placed over the subgrade.
- B. Subgrade Permeability:
  - 1. Subgrade should have a reasonable level of permeability. One suggested test for subgrade permeability is a double ring infiltrometer.
- C. Subgrade support:
  - 1. The subgrade shall be compacted by a mechanical vibratory compactor to 92 –95% of a maximum dry density as established by ASTM D1557 or AASHTO T180. Subgrade stabilization shall not be permitted.
  - 2. If fill material is required to bring the subgrade to final elevation (embankment), it shall be clean and free of deleterious materials. It shall be placed in 8" maximum layers, and compacted by a mechanical vibratory compactor to a minimum density of 92% of a dry density as established by ASTM D1557 or AASHTO T180.
- D. Subgrade Moisture:
  - 1. The subgrade shall be in a moist condition (+/- 3% of the optimum moisture content as determined by the modified compaction test ASTM D1557 or AASHTO T180).
- E. Forms:
  - 1. Forms may be of wood or steel and shall be the depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan profiles following spreading, strike-off and compaction operations. Forms shall have a removable spacer of ½" to 5/8" thickness placed above the depth of pavement. The spacers are removed following placement and vibratory strike-off to allow roller compaction. Forms shall allow for tie-in to adjacent concrete via the use of fiberglass reinforced plastic (FRP) reinforcing bar.

### 3.3 MIXING, HAULING AND PLACING

#### A. Mix Time:

1. Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

#### B. Transportation:

1. The Portland Cement aggregate mixture may be transported or mixed on-site and should be used within one hour of the introduction of mix water, unless otherwise approved by an engineer. This time can be increased to 90 minutes when utilizing the hydration stabilizer specified in Section 2.5 of this document.

#### C. Discharge:

1. Each mixer will be inspected for appearance of concrete uniformity. Water may be added to obtain the required mix consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following the addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and such that fresh concrete enters the mass of previously placed concrete.

#### D. Placing and Finishing:

1. Unless otherwise approved by the Owner or Engineer in writing, the Contractor shall provide mechanical equipment of either slipform or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force. The porous concrete pavement will be placed to the required cross-section and shall not deviate more than +/- 3/8" in 10 feet from profile grade.
2. Normal placement procedures involve utilizing a mechanical vibratory screed to strike off the concrete 1/2" to 5/8" above final height, utilizing the form spacers described in Section 4.5 of this document. Where the use of a vibratory screed can not be used traditional manual methods may be used to strike off the concrete. Following strike-off, the spacers are removed, and the concrete compacted to form level utilizing a steel roller made from nominal 8" diameter steel pipe. Care should be taken during compaction that full compactive force is achieved without working the concrete surface enough to seal off the surface porosity. Apparent defects in the surface can be remedied by placing some fresh mix into depressions and compacting using a hand tamper.
3. After roller compacting and defect inspection/fixing, no further finishing is performed on the concrete.

#### E. Curing:

1. Curing procedures shall begin within 20 minutes of final placement operations.
2. The pavement surface shall be covered with a minimum of 6ml thick polyethylene sheet or other approved covering material. The low water/cement ratio and high amount. The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions.

3. Cure Time: Cure times listed are ideal. Cover shall remain on during cure. No vehicular traffic shall be allowed for 10 days.

F. Jointing:

1. Control (contraction) joints shall be installed at regular intervals not to exceed 40 feet, or two times the width of the placement. They shall be installed at 1/4 the depth of the thickness of the pavement. These joints can be installed in the plastic concrete or saw-cut. Joints installed in the plastic concrete are generally rolled in utilizing a small roller with a flange welded to the center. This type of jointing is done immediately after roller compaction and immediately prior to curing.
2. If joints are saw-cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking, normally after 24 hours. Curing cover must be removed and recovered after joint sawing. Transverse construction joints shall be installed whenever placing is suspended long enough to allow the concrete to begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled or sprayed on existing pavement surface edge. Isolation (expansion) joints will not be used except when pavement is abutting slabs or other adjoining structures.

G. Grinding:

1. Upon completion of curing, concrete surface shall be ground. Grinding is performed to improve surface quality and increase durability by preventing future raveling. Surface is ground to the depth of the surface aggregate midpoint.

3.4 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, defective, or does not meet the requirements of this Section.
- B. Protect concrete from damage until Final Payment. Exclude traffic from paving for at least 28 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt and other foreign material until Final Payment.

3.5 CLEANUP

- A. At completion of Work, remove concrete stains from adjacent work, including but not limited to dissimilar paving types, walls, columns, railing posts, light fixtures, plant materials, to satisfaction of Owner's Authorized Representative.

3.6 PAVING FINISH SCHEDULE

- A. Provide paving finishes, as indicated on Paving Schedule on Drawings.

3.7 CLEANING AND PROTECTION

- A. When work is complete, clean entire paving installation using no acid cleaners unless favorable reviewed, in writing, by the Owner's Representatives.
- B. Protect finished installation from damage until final acceptance of entire project.

END OF SECTION

## SECTION 32 84 00 - PLANTING IRRIGATION

### PART 1 - **GENERAL**

#### 1.1 SUMMARY

- A. It is the intent of the specifications and drawings that the finished system is complete in every respect and shall be ready for operation satisfactory to the City.
- B. The work shall include materials, labor, services, transportation, and equipment necessary to perform the work as indicated on the drawings, in these specifications, and as necessary to complete the contract.

#### 1.2 CONSTRUCTION DRAWINGS

- A. Due to the scale of the drawings, it is not possible to indicate offsets, fittings, sleeves, etc. which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.
- B. Work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications. When an item is shown on the plans but not shown on the specifications or vice versa, it shall be deemed to be as shown on both. The Design Consultant shall have final authority for clarification.
- C. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the Design Consultant as soon as detected. In the event this notification is not performed, the Irrigation Contractor shall assume full responsibility for any revision necessary.

#### 1.3 QUALITY ASSURANCE

- A. Provide at least one English speaking person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who shall direct work performed under this section.
- B. Manufacturer's directions and detailed drawings shall be followed in cases where the manufacturer of articles used in this contract furnish directions covering points not shown in the drawings and specifications.
- C. Local, municipal, and state laws, rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.
- D. Materials supplied for this project shall be new and free from any defects. Defective materials shall be replaced immediately at no additional cost to the City.

- E. The Contractor shall secure the required licenses and permits including payments of charges and fees, give required notices to public authorities, verify permits secured or arrangements made by others affecting the work of this section.

#### 1.4 SUBMITTALS

- A. Submittals Materials List:
1. After award of contract and before any irrigation system materials are ordered from suppliers or delivered to the job site, submit to the City a complete list of irrigation system materials, or processes proposed to be furnished and installed as part of this contract.
  2. The submittals materials list shall include the following information:
    - a. A title sheet with the job name, the contractor's name, contractor's address and telephone number, submittal date and submittal number.
    - b. An index sheet showing the item number (i.e. 1,2,3, etc.); an item description (i.e. sprinkler head); the manufacturer's name (i.e. Hunter Industries); the item model number (i.e. I-40-ADV/36V); and the page(s) in the submittal set that contain the catalog cuts.
    - c. The catalog cuts shall be one or two pages copied from the most recent manufacturer's catalog that indicate the product submitted. Do not submit parts lists, exploded diagrams, price lists or other extra information.
    - d. The catalog cuts shall clearly indicate the manufacturer's name and the item model number. The item model number, the specified options and specified sizes shall be circled on the catalog cuts.
    - e. Submittals for equipment indicated on the legend without manufacturer names, or "as approved", shall contain the manufacturer, Class or Schedule, ASTM numbers and/or other certifications as indicated in these specifications.
  3. Submittal materials list format requirements:
    - a. Submittals shall be provided as one complete package for the project. Multiple partial submittals will not be reviewed.
    - b. Submittal package shall be stapled or bound in such a way as to allow for disassembly for review processing. Submittals shall not have tabs, tab sheets, spiral binding, or any other type of binding that will interfere with automated copying of submittals.
    - c. Submittal package shall have all pages numbered in the lower right hand corner. Page numbers shall correspond with submittal index.
    - d. Re-submitted packages must be revised to include only the equipment being re-submitted. Equipment previously reviewed and accepted shall not be re-submitted in the materials list/index sheet or in the catalog cut sheet package.
- B. Substitutions: If the Irrigation Contractor wishes to substitute any equipment or materials for those equipment or materials listed on the irrigation drawings and specifications, he may do so by providing the following information to the Design Consultant or the City's authorized representative for approval.
1. Provide a written statement indicating the reason for making the substitution.
  2. Provide catalog cut sheets, technical data, and performance information for each substitute item.
  3. Provide in writing the difference in installed price if the item is accepted.
- C. The Design Consultant will allow no substitutions without prior written acceptance.
- D. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
- E. The Design Consultant will not review the submittal package unless provided in the format described above.

## 1.5 EXISTING CONDITIONS

- A. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water connection to the irrigation system.
- B. Irrigation design is based on the available static water pressure shown on the drawings. Contractor shall verify static water on the project prior to the start of construction. Should a discrepancy exist, notify the Design Consultant prior to beginning construction.
- C. Prior to cutting into the soil, the Contractor shall locate cables, conduits, sewer septic tanks, and other utilities as are commonly encountered underground and he shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the Contractor shall promptly notify the Design Consultant who will arrange for relocations. The Contractor will proceed in the same manner if a rock layer or any other such conditions are encountered.
- D. The Contractor shall protect existing utilities and features to remain on and adjacent to the project site during construction. Contractor shall repair, at his own cost; all damage resulting from his operations or negligence.
- E. The Irrigation Contractor shall coordinate with the General Contractor for installation of required sleeving as shown on the plans prior to paving operations.
- F. The Contractor shall verify and be familiar with the existing irrigation systems in areas adjacent to and within the Project area of work.
- G. The Contractor shall protect existing irrigation systems, in areas adjacent to and within the project area of work, from damage due to his operations.
- H. Contractor shall notify the Design Consultant if any existing system is temporarily shut off, capped or modified. Provide 48-hour notice, prior to turning off or modifying any existing irrigation system.
- I. The Contractor shall repair or replace existing irrigation systems, in areas adjacent to and within the project area of work, damaged by the construction of this project. Adjacent irrigation systems shall be made completely operational and provide complete coverage of the existing landscaped areas. All repairs shall be complete to the satisfaction of the Design Consultant
- J. The contractor shall provide bore holes under any existing pavement or paving encountered for the required lateral, mainline and low voltage control wire sleeving. Bore holes under 2 inches in diameter and smaller shall be made with a BulletMole® underground boring tool as manufactured by Dimension Tools, LLC (Contact telephone number (888)-650-5554 or at [www.bulletmole.com](http://www.bulletmole.com)). Bore holes larger than 2 inches in diameter shall be made with an approved mechanical boring tool. No air jacking or hydraulic boring of any kind shall be allowed.

## 1.6 INSPECTIONS

- A. The Contractor shall permit the Design Consultant to visit and inspect any part of the work and shall provide safe access for such visits.
- B. Where the specifications require work to be tested by the Contractor, it shall not be covered over until accepted by the Design Consultant, , and/or governing agencies. The Contractor shall be solely responsible for notifying the Design Consultant, , and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should any



work be covered without testing or acceptance, it shall be, if so ordered, uncovered at the Contractor's expense.

- C. Inspections will be required for the following at a minimum:
  - 1. Pre-construction meeting.
  - 2. System layout.
  - 3. Pressure test of irrigation mainline (Four hours at 125 PSI or 120% of static water pressure, whichever is greater.) Mainline pressure loss during test shall not exceed 2 PSI.
  - 4. Coverage test of irrigation system. Test shall be performed prior to any planting.
  - 5. Final inspection prior to start of maintenance period.
  - 6. Final acceptance prior to turnover.
- D. Site observations and testing will not commence without the field record drawings as prepared by the Irrigation Contractor. Record drawings must complete and up to date for each site visit.
- E. Work that fails testing and is not accepted will be retested. Hourly rates and expenses of the Design Consultant, and governing agencies for re-inspection or retesting will be paid by the Irrigation Contractor at no additional expense to the City.

#### 1.7 STORAGE AND HANDLING

- A. Use means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of other trades. In the event of damage, immediately make repairs and replacements necessary to the acceptance of the Design Consultant and at no additional cost to the City.
- B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.

#### 1.8 CLEANUP AND DISPOSAL

- A. Dispose of waste, trash, and debris in accordance with applicable laws and ordinances and as prescribed by authorities having jurisdiction. Bury no such waste material and debris on the site. Burning of trash and debris will not be permitted. The Contractor shall remove and dispose of rubbish and debris generated by his work and workmen at frequent intervals or when ordered to do so by the design Consultant.
- B. At the time of completion the entire site will be cleared of tools, equipment, rubbish and debris which shall be disposed of off-site in a legal disposal area.

#### 1.9 TURNOVER ITEMS

- A. Record Drawings:
  - 1. Record accurately on one set of drawings changes in the work constituting departures from the original contract drawings and the actual final installed locations of required components as shown below.
  - 2. The record drawings shall be prepared to the satisfaction of the City. Prior to final inspection of work, submit record drawings to the Design Consultant..
  - 3. Record drawings shall be prepared using AutoCAD 2012 drafting software and the original irrigation drawings as a base. No manual drafted record drawings shall be acceptable. The Contractor may obtain digital base files from the Design Consultant.
  - 4. If the Contractor is unable to provide the AutoCAD drafting necessary for the record drawings the irrigation designer does provide record drawing drafting as a separate service.

5. Prior to final inspection of work, submit record drawings plotted onto vellum sheets for review by the Design Consultant. After acceptance by the Design Consultant, City Inspector re-plot the record drawings onto reproducible Mylar sheets. The Contractor shall also provide record drawing information on a digital AutoCAD Release 2012 drawing file. Digital files shall be provided on a compact disc (CD) clearly marked with the project name, file descriptions and date.
    - a. Record drawing information and dimensions shall be collected on a day-to-day basis during the installation of the pressure mainline to fully indicate routing locations and pipe depths. Locations for other irrigation equipment shall be collected prior to the final inspection of the work.
    - b. Two dimensions from two permanent points of reference such as buildings, sidewalks, curbs, streetlights, hydrants, etc. shall be shown for each piece of irrigation equipment shown below. Where multiple components are installed with no reasonable reference point between the components, dimensioning may be made to the irrigation equipment. Irrigation symbols shall be clearly shown matching the irrigation legend for the drawings. Lettering on the record drawings shall be minimum 1/8 inch in size.
  6. Show locations and depths of the following items:
    - a. Point of connection (including water POC, backflow devices, master control valves, flow sensors, etc.)
    - b. Routing of sprinkler pressure main lines (dimensions shown at a maximum of 100 feet along routing)
    - c. Isolation valves
    - d. Automatic remote control valves (indicate station number and size)
    - e. Quick coupling valves
    - f. Drip air relief and flush valves
    - g. Routing of control wires where separate from irrigation mainline
    - h. Irrigation controllers (indicate controller number and station count)
    - i. Related equipment (as may be directed)
- B. Controller Charts:
1. Provide one controller chart for each automatic controller. Chart shall show the area covered by the particular controller. The areas covered by the individual control valves shall be indicated using colored highlighter pens. A minimum of six individual colors shall be used for the controller chart unless less than six control valves are indicated.
  2. Design Consultant must approve record drawings before controller charts are prepared.
  3. The chart is to be a reduced copy of the actual "record" drawing. In the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a readable size.
  4. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness.
- C. Operation and Maintenance Manuals:
1. Two individually bound copies of operation and maintenance manuals shall be delivered to the Design Consultant at least 10 calendar days prior to final inspection. The manuals shall describe the material installed and the proper operation of the system.
  2. Each complete, bound manual shall include the following information:
  3. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment including names and addresses of local manufacturer representatives.
    - a. Operating and maintenance instructions for equipment.
    - b. Spare parts lists and related manufacturer information for equipment.
- D. Equipment:
1. Supply as a part of this contract the following items:
    - a. Two (2) wrenches for disassembly and adjustment of each type of sprinkler head used in the irrigation system.

- b. Three 30-inch sprinkler keys for manual operation of control valves.
  - c. Two keys for each automatic controller.
  - d. Two quick coupler keys with a 3/4" bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
  - e. One valve box cover key or wrench.
  - f. Six extra sprinkler heads of each size and type.
2. The above equipment shall be turned over to Design Consultant at the final inspection.

#### 1.10 COMPLETION

- A. At the time of the pre-maintenance period inspection, the Design Consultant, and governing agencies will inspect the work, and if not accepted, will prepare a list of items to be completed by the Contractor. Punch list to be checked off by contractor and submitted to Design Consultant prior to any follow-up meeting. This checked off list to indicate that all punch list items have been completed. At the time of the post-maintenance period or final inspection the work will be re-inspected and final acceptance will be in writing by the Design Consultant, , and governing agencies.
- B. The Design Consultant shall have final authority on all portions of the work.
- C. After the system has been completed, the Contractor shall instruct Design Consultant in the operation and maintenance of the irrigation system and shall furnish a complete set of operating and maintenance instructions.
- D. Any settling of trenches which may occur during the one-year period following acceptance shall be repaired to the City's satisfaction by the Contractor without any additional expense to the City. Repairs shall include the complete restoration of damage to planting, paving or other improvements of any kind as a result of the work.

### PART 2 - MATERIALS

#### 2.1 SUMMARY

Use only new materials of the manufacturer, size and type shown on the drawings and specifications. Materials or equipment installed or furnished that do not meet Design Consultant's, City's, or governing agencies standards will be rejected and shall be removed from the site at no expense to the City.

#### 2.2 PIPE

- A. Pressure supply lines 2 inches in diameter and up to 3 inches in diameter downstream of backflow prevention unit shall be Class 315 solvent weld PVC. Piping shall conform to ASTM D2241.
- B. Non-pressure lines 3/4 inch in diameter and larger downstream of the remote control valve shall be SCH 40 solvent weld PVC conforming to ASTM D1785.

#### 2.3 METAL PIPE AND FITTINGS

- A. Brass pipe shall be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.
- B. Fittings shall be medium brass, screwed 125-pound class.

- C. Copper pipe and fittings shall be Type "K" sweat soldered, or brazed as indicated on the drawings.

## 2.4 PLASTIC PIPE AND FITTINGS

- A. Pipe shall be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.
- B. Plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2672, ASTM D2241 or ASTM D1785.
- C. Solvent weld PVC fittings shall be standard weight Schedule 40 (and Schedule 80 where specified on the irrigation detail sheet, mainline fittings shall be Schedule 80 PVC) and shall be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings shall be the "deep socket" bracketed type. Threaded plastic fittings shall be injection molded. All tees and ells shall be side gated. Fittings shall conform to ASTM D2464 and ASTM D2466.
- D. Threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.
- E. Solvent cementing of plastic pipe and fittings shall be a two-step process, using primer and solvent cement applied per the manufacturer's recommendations. Cement shall be of a fluid consistency, not gel-like or ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
- F. When connection is plastic to metal, female adapters shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be non-lead base Teflon paste, tape, or equal.
- G. Pressure mainlines installed with solvent weld PVC fittings shall be installed with concrete thrust blocking at directional changes in the mainline routing. Concrete thrust blocking shall not be required when ductile iron fittings and mechanical restraints are specified.

## 2.5 VALVES

- A. Butterfly Valves:
  - 1. Butterfly valves shall be of the manufacturer, size, and type indicated on the drawings.
  - 2. Butterfly valves shall have cast iron bodies, and stainless steel stems. Butterfly valves shall have ductile iron porcelain enamel coated disc.
  - 3. Butterfly valves shall have a minimum working pressure of not less than 150 PSI and shall conform to AWWA standards.
- B. Quick Coupler Valves:
  - 1. Quick coupler valves shall be of the manufacturer, size, and type indicated on the drawings.
  - 2. Quick coupler valves shall be brass with a wall thickness guaranteed to withstand normal working pressure of 150 psi without leakage. Valves shall have 1" female threads opening at base, with two-piece body. Valves to be operated only with a coupler key, designed for that purpose. Coupler key is inserted into valve and a positive, watertight connection shall be made between the coupler key and valve.
- C. Automatic Control Valves:
  - 1. Automatic control valves shall be of the manufacturer, size, and type indicated on the drawings.
  - 2. Automatic control valves shall be electrically operated.
  - 3. Provide Christy's valve ID tags for each remote control valve with valve number.

## 2.6 VALVE BOXES

- A. Valve boxes shall be fabricated from a durable, weather-resistant plastic material resistant to sunlight and chemical action of soils.
- B. The valve box cover shall be green in color and secured with a hidden latch mechanism or bolts.
- C. The cover and box shall be capable of sustaining a load of 1,500 pounds.
- D. Valve box extensions shall be by the same manufacturer as the valve box.
- E. The plastic irrigation valve box cover shall be an overlapping type.
- F. Automatic control valve boxes shall be 17"x11"x12" 'nominal' rectangular size. Valve box covers shall be marked "RCV" with the valve identification number "heat branded" onto the cover in 1-1/4 inch high letters / numbers.
- G. Drip flush valve and Air relief valve boxes shall be 6" circular size. Valve box covers shall be marked with "FV" or "ARV" "heat branded" onto the cover in 1-1/4 inch high letters.
- H. Quick coupler and butterfly valve boxes shall be 10" circular size. Valve box covers shall be marked with "QCV" "heat branded" onto the cover in 1-1/4 inch high letters.

## 2.7 AUTOMATIC CONTROLLER

- A. Automatic controller shall be of the manufacturer, size, and type indicated on the drawings.
- B. Controller enclosure shall be of the manufacturer, size, and type indicated on the drawings.
- C. Controller shall be grounded according to local codes using equipment of the manufacturer, size, and type indicated on the drawings; or as required by local codes and ordinances.

## 2.8 ELECTRICAL

- A. Electrical equipment shall be NEMA Type 3, waterproofed for exterior installations.
- B. Electrical work shall conform to local codes and ordinances.

## 2.9 LOW VOLTAGE CONTROL WIRING

- A. Remote control wire shall be direct-burial AWG-UF type, size as indicated on the drawings, and in no case smaller than 14 gauge.
- B. Connections shall of the manufacturer, size, and type indicated on the drawings.
- C. Common wires shall be white in color. Control wires shall be red (where two or more controllers are used, the control wires shall be a different color for each controller. These colors shall be noted on the "Record Drawings" plans located on controller door).
- D. Ground wires shall be green in color or bare copper and in no case smaller than 6 gauge.

## 2.10 IRRIGATION HEADS AND DRIP EMITTERS AND INLINE DRIP TUBING

- A. Irrigation heads, drip emitters and inline drip tubing shall be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the drawings.

- B. Irrigation heads, drip emitters and inline drip tubing shall be used as indicated on the drawings.

## 2.11 DRIP IRRIGATION EQUIPMENT

Drip tubing equipment such as flush valves, air relief valves, wye strainers and pressure regulators shall be of the manufacturer, size, and type indicated on the drawings.

## 2.12 MISCELLANEOUS EQUIPMENT

- A. Landscape Fabric:
  - 1. Landscape fabric for valve box assemblies shall be 5.0- oz. weight woven polypropylene weed barrier. Landscape fabric shall have a burst strength of 225 PSI, a puncture strength of 60 lbs. and capable of water flow of 12 gallons per minute per square foot.
  - 2. Type: DeWitt Pro 5 Weed Barrier or approved equal.
- B. Equipment such as flush valves, air relief valves, and wye strainers shall be of the manufacturer, size and type indicated on the drawings.

## PART 3 - EXECUTION

### 3.1 SITE CONDITIONS

- A. Inspections:
  - 1. Prior to work of this section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
  - 2. Verify that irrigation system may be installed in strict accordance with pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Discrepancies:
  - 1. In the event of discrepancy, immediately notify the Design Consultant.
  - 2. Do not proceed with installation in areas of discrepancy until discrepancies have been resolved.
- C. Grades:
  - 1. Before starting work, carefully check grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
  - 2. Final grades shall be accepted by the Engineer before work on this section will be allowed to begin.
- D. Field Measurements:
  - 1. Make necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor shall coordinate the installation of irrigation materials with other work.
  - 2. Scaled dimensions are approximate. The Contractor shall check and verify size dimensions prior to proceeding with work under this section.
  - 3. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities, which are caused by his operations or neglect.
- E. Diagrammatic Intent:

The drawings are essentially diagrammatic. The size and location of equipment and fixtures are drawn to scale where possible. Provide offsets in piping and changes in equipment locations as necessary to conform with structures and to avoid obstructions or conflicts with other work at no additional expense to City.

- F. Layout:
1. Prior to installation, the Contractor shall stake out pressure supply lines, routing and location of sprinkler heads, valves, backflow preventer, and automatic controller.
  2. Layout irrigation system and make minor adjustments required due to differences between site and drawings. Where piping is shown on drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.
- G. Water Supply:
- Connections to, or the installation of, the water supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made at no additional expense to City.
- H. Electrical Service:
1. Connections to the electrical supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made at no additional expense to City.
  2. Contractor shall make electrical connections to the irrigation controller. Electrical power source to controller locations shall be provided by others.
  3. Contractor shall make electrical connections to the irrigation controller. 230-volt single-phase electrical power source to pump assembly location shall be provided by others per NEC codes.

### 3.2 TRENCHING

- A. Excavations shall be straight with vertical sides, even grade, and support pipe continuously on bottom of trench. Trenching excavation shall follow layout indicated on drawings to the depths below finished grade and as noted. Where lines occur under paved area, these dimensions shall be considered below subgrade.
- B. Provide minimum cover of 24 inches on pressure supply lines 3 inches and larger.
- C. Provide minimum cover of 18 inches for control wires within planters.
- D. Provide minimum cover of 24 inches for control wires within sleeves below paving.
- E. Provide minimum cover of 36 inches on pressure supply lines under vehicular travel ways.
- F. Provide minimum cover of 12 inches for non-pressure lines.
- G. Pipes installed in a common trench shall have a 4-inch minimum space between pipes.

### 3.3 THRUST BLOCKS

- A. Thrust blocks must be constructed of Class "B" concrete.
- B. Thrust blocks shall be poured against undisturbed site soil.
- C. PVC fitting joints shall be kept free of concrete. Do not encase fitting in concrete.
- D. Thrust blocking shall be sized to provide the minimum bearing areas as shown below. Bearing areas indicated have been calculated for Class 200 PVC pipe at a test pressure of 150 PSI in soil with 2,000 PSI bearing capacity. Increase thrust block sizing as necessary for varying soil conditions.
1. Provide a minimum thrust block bearing area of 2.0 square feet on bends (all degrees) and tees installed on pressure supply lines 4 inches and smaller.

### 3.4 BACKFILLING

- A. Backfill material on lines shall be the same as adjacent soil free of debris, litter, and rocks over 1/2 inches in diameter.
- B. Backfill shall be tamped in 4-inch layers under the pipe and uniformly on both sides for the full width of the trench and the full length of the pipe. Backfill materials shall be sufficiently damp to permit thorough compaction, free of voids. Backfill shall be compacted to dry density equal to adjacent undisturbed soil and shall conform to adjacent grades.
- C. Flooding in lieu of tamping is not allowed.
- D. Under no circumstances shall truck wheels be used to compact backfill.
- E. Provide sand backfill a minimum of 4 inches over and under piping under paved areas.

### 3.5 PIPING

- A. Piping under existing pavement may be installed by jacking, boring, or hydraulic driving. No hydraulic driving is permitted under asphalt pavement.
- B. Cutting or breaking of existing pavement is not permitted.
- C. Carefully inspect pipe and fittings before installation, removing dirt, scale, burrs, and reaming. Install pipe with markings up for visual inspection and verification.
- D. Remove dented and damaged pipe sections.
- E. Lines shall have a minimum clearance of 4 inches from each other and 12 inches from lines of other trades.
- F. Parallel lines shall not be installed directly over each other.
- G. In solvent welding, use only the specified primer and solvent cement and make joints in strict accordance with the manufacturer's recommended methods including wiping excess solvent from each weld. Allow solvent welds at least 15 minutes setup time before moving or handling and 24 hours curing time before filling.
- H. PVC pipe shall be installed in a manner, which will provide for expansion and contraction as recommended by the pipe manufacturer.
- I. Center load plastic pipe prior to pressure testing.
- J. Threaded plastic-to-plastic connections shall be assembled using Teflon tape or Teflon paste.
- K. For plastic-to-metal connections, work the metal connections first. Use a non-hardening pipe dope a threaded plastic-to-metal connections, except where noted otherwise. Plastic-to-metal connections shall be made with plastic female adapters.

### 3.6 CONTROLLER

- A. The exact location of the controller shall be approved by the Design Consultant before installation. The electrical service shall be coordinated with this location.
- B. The Irrigation Contractor shall be responsible for the final electrical hook up to the irrigation controller.



- C. The irrigation system shall be programmed to operate during the periods of minimal use of the design area.

### 3.7 CONTROL WIRING

- A. Low voltage control wiring shall occupy the same trench and shall be installed along the same route as the pressure supply lines whenever possible.
- B. Where more than one wire is placed in a trench, the wiring shall be taped together in a bundle at intervals of 10 feet. Bundle shall be secured to the mainline with tape at intervals of 20 feet.
- C. Connections shall be of an approved type and shall occur in a valve box. Provide an 18-inch service loop at each connection.
- D. An expansion loop of 12 inches shall be provided at each wire connection and/or directional change, and one of 24 inches shall be provided at each remote control valve.
- E. A continuous run of wire shall be used between a controller and each remote control valve. Under no circumstances shall splices be used without prior approval.

### 3.8 VALVES

- A. Automatic control valves, quick coupler, and gate valves are to be installed in the approximate locations indicated on the drawings.
- B. Valve shall be installed in shrub areas whenever possible.
- C. Install valves as indicated in the detail drawings.
- D. Valves to be installed in valve boxes shall be installed one valve per box.
- E. Provide valve ID tags for each remote control valve with valve number.

### 3.9 VALVE BOXES

- A. Valve boxes shall be installed in shrub areas whenever possible.
- B. Each valve box shall be installed on a foundation of 3/4 inch gravel backfill, 3 cubic feet minimum. Valve boxes shall be installed with their tops 1/2 inch above the surface of surrounding finish grade in lawn areas and 2 inches above finish grade in ground cover areas.

### 3.10 IRRIGATION HEADS DRIP EMITTERS AND INLINE DRIP TUBING

- A. Irrigation heads, drip emitters and inline drip tubing shall be installed as indicated on the drawings.
- B. Spacing of heads and inline drip tubing shall not exceed maximum indicated on the drawings.
- C. Riser nipples shall be of the same size as the riser opening in the sprinkler body.

### 3.11 MISCELLANEOUS EQUIPMENT

- A. Install assemblies specified herein according to the respective detail drawings or specifications, using best standard practices.

- B. Quick coupler valves shall be set approximately 18 inches from walks, curbs, header boards, or paved areas where applicable.
- C. Install devices such as flush valves, and air relief valves as indicated on the drawings and as recommended by the manufacturer.

### 3.12 FLUSHING THE SYSTEM

- A. Prior to installation of irrigation heads, the valves shall be opened and a full head of water used to flush out the lines and risers.
- B. Irrigation heads shall be installed after flushing the system has been completed.

### 3.13 ADJUSTING THE SYSTEM

- A. Contractor shall adjust valves, align heads, and check the coverage of each system prior to coverage test.
- B. If it is determined by the Design Consultant that additional adjustments or nozzle changes will be required to provide proper coverage, necessary changes or adjustments shall be made prior to any planting.
- C. The entire system shall be operating properly before any planting operations commence.
- D. Automatic control valves are to be adjusted so that the irrigation heads, drip emitters and inline drip tubing operate at the pressure recommended by the manufacturer.

### 3.14 TESTING AND OBSERVATION

- A. Do not allow or cause any of the work of this section to be covered up or enclosed until it has been observed, tested and accepted by the Design Consultant, City, and governing agencies.
- B. The Contractor shall be solely responsible for notifying the Design Consultant, City, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing.
- C. When the sprinkler system is completed, the Contractor shall perform a coverage test of each system in its entirety to determine if the water coverage for the planted areas is complete and adequate in the presence of the Design Consultant.
- D. The Contractor shall furnish materials and perform work required to correct any inadequacies of coverage due to deviations from the plans, or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate, without bringing this to the attention of the Design Consultant. This test shall be accepted by the Design Consultant and accomplished before starting any planting.
- E. Areas to be maintained for the formal maintenance period shall start maintenance at the same time, as directed by the Design Consultant, City, and governing agencies. Partial areas will not be released into maintenance prior to completion of items listed in the pre-maintenance review. The maintenance period may not be phased.
- F. Final inspection will not commence without record drawings as prepared by the Irrigation Contractor.

### 3.15 MAINTENANCE

During the maintenance period the Contractor shall adjust and maintain the irrigation system in a fully operational condition providing complete irrigation coverage to intended plantings.

### 3.16 COMPLETION CLEANING

Clean up shall be made as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, walks and paving shall be swept, and any damage sustained on the work of others shall be repaired to original conditions.

END OF SECTION

## SECTION 32 90 50 - LANDSCAPE BOULDERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Furnish and Install Landscape Boulders.
- B. Related Sections include the following:
  - 1. Section 01 10 10 - Sustainable Design Requirements.
  - 2. Division 12 Section "Site Furnishings" for benches installed in boulders
  - 3. Division 05 Section "Pipe and Tube Railings" for fabrication and installation requirements for pipe and tube railings.
  - 4. Division 31 Section "Site Clearing" for removal limits of trees, shrubs, and other plantings affected by new construction.
  - 5. Division 31 Section "Earth Moving" for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.
  - 6. Division 32 Section "Plants" and "Turf and Grasses" for coordination with adjacent planting areas.
  - 7. Division 32 Section "Planting Irrigation" for coordination with adjacent irrigation systems.
  - 8. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

#### 1.3 REFERENCES

- A. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

#### 1.4 SUBMITTALS

- A. Product Data: For the following: Natural Landscape Boulders.
- B. Samples for Initial Selection: Photographs of each rock type, as indicated on Drawings, label with ID number, approximate location off site, color and size range.
  - 1. Provide photographs of a selection (50% more than number required) of boulders to choose from.
  - 2. Submit rock types in one submittal.

3. Natural Landscape Boulders: Submit three photographs of each stone taken from different angles with name, size (height, width and length), color range and source. Tag each boulder and include boulder ID number in each photograph for identification purposes.
- C. Shop Drawings showing spot elevations and locations of boulders including depth to be buried as appropriate.
- D. Provide certification from rock quarry that stones – natural boulders, slab rocks, rip-rap broken stone used in rock landform and rock mulch - are purchased from a single source supplier. If more than one quarry is to be utilized, suppliers must have access to multiple quarries, stone approval from Design Consultant must be obtained prior to installation.
- E. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  1. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.5 QUALITY ASSURANCE

- A. Contractor Qualifications: An experienced Contractor who has completed landscape boulder 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.
- B. Source Limitations: Obtain each type of rock from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect rock during storage and construction from mixing with earth or other materials.
- B. Identify adequate location for sorting and storage of each rock type on site.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

##### A. Boulders

1. Landscape Boulders:
  - a. Type and Size: Per drawings
  - b. Acceptable Manufacturers:
    - 1) Decorative Stone Solutions (800) 699-1878
    - 2) KRC (760) 744-1035
    - 3) Southwest Boulder (800) 540-1147
    - 4) Or Equal
2. Landscape Flagstone:
  - a. Type and Size: Per drawings
  - b. Acceptable Manufacturers:
    - 1) Decorative Stone Solutions (800) 699-1878
    - 2) KRC (760) 744-1035
    - 3) Southwest Boulder (800) 540-1147
    - 4) Or Equal

- B. Quality Requirements: Visual evaluation of the quarry, including examination of samples, suitable tests and service records may be used to determine acceptability of the stone. The Contractor shall notify the Agency in writing of the intended source of stone at least 60 days prior to use.

## 2.2 CLEANING

- A. Boulders and slab rocks shall be free of graffiti. Graffiti is defined as paint or indelible markers which mar the appearance of the boulders. If graffiti removal is required, contractor shall prepare a schedule of materials and methods for graffiti removal and proposed methods of protecting the site from chemical contamination. The schedule shall be submitted to the Engineer prior to proceeding with graffiti removal. The Contractor shall be responsible for the complete removal of graffiti during the contract and maintenance period under this item.

## 2.3 COLORS AND ROCK TYPE

- A. As indicated on the Drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas indicated to receive landscape natural boulders or flagstone steppers with Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SUBGRADE PREPARATION

- A. Prior to the placement of the landscape natural boulders, the subgrade surfaces shall be cut, filled, compacted, and graded to the lines and grades as shown on the project drawings. Subgrade surfaces shall be prepared so as to be reasonably smooth, and free of mounds, dips or windows.
- B. The placement of fill to meet design grades and elevations shall be of an approved material and placement shall include adequate compaction of the materials.
- C. No natural boulders shall be placed until the subgrade is inspected and approved by the design Consultant.
- D. The Contractor shall provide for an adequate foundation under the natural boulders per the Drawings.
- E. Boulder to be placed so a flat surface faces up with no protrusions facing vertically or rough edges exposed.

### 3.3 STONE PLACEMENT

- A. No setting of boulders shall take place unless the Design Consultant is present on the site.
- B. The locations of stones are designated in the Drawings; however the exact position of each stone shall be as directed by the Design Consultant.
- C. The stone shall be placed by equipment on the surfaces and to the depths specified. The Stone shall be as to avoid displacement of the underlying subgrade or bedding aggregate.

3.4 EQUIPMENT PLACEMENT

- A. Rock shall have a maximum contact between the individual rock, without bridging or otherwise creating a void under the stone. The rock shall be firmly bedded, and may be placed by hand or by machinery.
- B. Contractor to take appropriate measures to avoid damage to the stone and pavement.

END OF SECTION

SECTION 32 92 00 - TURF AND GRASSES

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Sodding.
  - 2. Turf renovation.
  - 3. Erosion-control material(s).
- B. Related Sections:
  - 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
  - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
  - 3. Division 32 Section "Planting Irrigation" for turf irrigation.
  - 4. Division 32 Section "Plants" for border edgings.
  - 5. Division 33 Section "Subdrainage" for subsurface drainage.
  - 6. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

1.3 REFERENCES

- A. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

1.4 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.



- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: Soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
  - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- C. Qualification Data: For qualified landscape Installer.
- D. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- E. Material Test Reports: For existing in-place surface soil and imported or manufactured topsoil.
- F. Maintenance Instructions: Recommended procedures to be established by the Design Consultant for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.
- G. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  - 2. Experience: Five years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certifications: Installer's field supervisor shall have certification in one the following categories from the Professional Landcare Network:
    - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
    - b. Certified Turfgrass Professional, designated CTP.
    - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
  - 5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
  - 6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.
  - 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
  - 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Design Consultant at locations identified on the plans.
  - 3. Report suitability of tested soil for turf growth.
    - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and

potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

- b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Preinstallation Conference: Conduct conference at Project site.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk fertilizers, and soil amendments with appropriate certificates.

#### 1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

#### 1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
  - 1. Sodded Turf: 180 days from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 TURFGRASS SOD**

- A. Turfgrass Sod: Complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: As indicated on drawings

### **2.2 IMPORT TOPSOIL**

- A. Import topsoil to be used on-grade as required for fill operations or as specified in the drawings.
- B. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0 millimeter sieve. The sodium absorption rate (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract. Submit results of agricultural soils analysis for review and approval by the Design Consultant.
- C. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 2 percent organic material content; free of stones 1 inch or larger in dimension and other extraneous materials harmful to plant growth.

### **2.3 INORGANIC SOIL AMENDMENTS**

- A. Soil amendments will vary depending on the results of soil testing.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

### **2.4 ORGANIC SOIL AMENDMENTS**

- A. Organic Soil Amendment:
  - 1. A blend of organic fractions with several degrees of breakdown rate, a long-lasting form of iron, trace elements, pH of 5.5 to 7.5, maximum salinity of 2.50 ECe, organic matter (dry weight basis) more than 90%, non-ionic wetting agent and total nitrogen content of 0.4 – 0.8% ("Numex Lif" by John Deere Landscape (800) 233-6933, or "A-1 Nutri-Gro" by Hanson Aggregates/A-1 Soils or as indicated on the Drawings.

## 2.5 FERTILIZER

### A. Pre-plant Fertilizer:

1. Gro-Power Plus 5-3-1, or equal, Soil Penetrant Added (1.00% Alkyl Naphthalene Sodium Sulfonate.) Fertilizer and soil conditioner from organic materials, higher plant form life, composted below the fibrous stage to support bacterial cultures. Shall not contain poultry, animal or human waste. As manufactured by Gro-Power®, Inc. (800) 473-1307, or equal.
2. Physical properties: A uniform "Beaded" homogenous mixture - 100.00% passing through a #4 mesh screen - a water soluble bio-degradable binder is used to insure fast breakdown.
3. Chemical Analysis: 5-3-1, nitrogen (available) 5.00%, phosphate 3.00%, potash 1.00% humus 70.00%, humic acids 15.00% soil penetrant 1.00%. Gro-Power bacterial "stimulator" included -bacteria (common soil and airborne organisms - aerobic, anaerobic,) yeast and mold, minimum 60,000 per 100 gram.

Nitrogen	5%	minimum
Phosphoric Acid	3%	minimum
Soluble Potash	1%	minimum

### B. Lawn Post-plant Fertilizer:

1. Gro-Power Premium High Nitrogen 18-3-7 NPK analysis, with 40% of the nitrogen a slow release SCU. 20% humus, 4% humic Acids, 4% sulfur, 1% iron, 0.50% soil penetrant, and soil enhancers. Nitrogen source: 5.94% Ammoniacal Nitrogen, 4.86% Nitrate Nitrogen, 5.40% Sulphur Coated Slow-Release Nitrogen, 1.08% Urea Nitrogen. Gro-Power bacterial "stimulator" included -bacteria (common soil and airborne organisms - aerobic, anaerobic,) yeast and mold, minimum 60,000 per 100 gram. As manufactured by Gro-Power®, Inc. (800) 473-1307, or equal.

Nitrogen	18%	minimum
Phosphoric Acid	3%	minimum
Soluble Potash	7%	minimum

### C. Planting Tablets:

1. Tightly compressed chip type commercial grade planting tablets, and containing the following available percentages by weight of plant food:

Nitrogen	20%	minimum
Phosphoric Acid	10%	minimum
Potash	5%	minimum
2. Mycorrhizal Inoculum / Soil Conditioner: Inoculum shall be both Endo and Ecto (granular), with consisting of propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species *Glomus intraradices*, *Glomus aggregatum*, *Glomus mosseae*, combined with other species and/or additional genera including, *Sclerocystis*, *Gigaspora*, *Scutellospora*, *Entrophospora*, and *Acaulospora*. Ectomycorrhiza include *Pisolithus* and 4 species of *Rhizopogon*. Soil Conditioner portion shall consist of organic materials

consisting of higher plant form life, composted beyond the fibrous stage, to humus. Also shall have humic acids and beneficial soil bacteria strains. It shall NOT contain poultry, animal or human waste (i.e., sewage sludge), pathogenic viruses, fly larvae, insecticides, herbicides, fungicide or poisonous chemicals that would inhibit plant growth. Shall be "GroLife" (800) 473-1307, or equal.

Ingredients percentage (minimum)

Mycorrhizal Inoculum 6,500/55,00 propagules per lb.\*

Humus 65%

Humic Acids 25%

## 2.6 EROSION-CONTROL MATERIALS

- D. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- E. Erosion-Control Fiber Mesh: Jute mesh shall be new and shall be of a uniform, open, plain-weave mesh. The mesh shall be made from unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than half its normal diameter. Jute mesh shall be furnished in rolled strips and shall conform to the following provisions:
  - 1. Width - 1200 mm {48 inches}, with a tolerance of  $\pm 25$  mm { $\pm$  one inch}.
  - 2. Warp ends - 78, minimum, per width.
  - 3. Weft ends - 44, minimum, per meter {yard}.
  - 4. Mass - 0.57 to 0.63-kg/m {1.16 to 1.28 pounds per yard}.

## 2.7 MISCELLANEOUS PRODUCTS

- F. Prior to using herbicides, contractor shall review procedures with the Design Consultant and obtain written approval. A contractor licensed by the County shall perform herbicide applications requiring government or agency approvals.
- G. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.
- H. Pre-emergent herbicide shall be Treflan, Surfland, Eptan, or equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils,

gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
  3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Design Consultant and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off City's property.
1. Spread soil conditioner, gypsum and other amendments over planting areas indicated on the Drawings, and mechanically till and blend to a depth of 6 inches.
  2. Prepare areas within the dripline of existing trees by hand, do not use mechanical tillers. Rake smooth, lightly water, and compact to the finish grades shown on the Drawings. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests.
  3. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests.
    - a. Soil Conditioner 6 cubic yards/ 1000s.f.
    - b. Gypsum 100 lbs/ 1000s.f.
    - c. Pre-Plant Fertilizer 5-3-1/ 150 lbs. / 1000s.f.
    - d. Soil Sulfur 10 lbs. / 1000s.f.
    - e. Mycorrhizal Inoculum / Soil Conditioner 20 lbs. / 1000s.f.

4. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
5. Thoroughly blend planting soil mix off-site before spreading, apply soil amendments on surface, and thoroughly blend planting soil mix.
6. Spread planting soil mix to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is, muddy, or excessively wet.
  - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
  - b. Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod.
  - c. For turfgrass only: Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1”.

### 3.4 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  1. Lay sod across angle of slopes exceeding 1:3.
  2. Anchor sod on slopes exceeding 1:6 with wood peg] spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.5 TURF RENOVATION

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
  1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
  2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.



- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off City's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 6 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Water newly planted areas and keep moist until new turf is established.

### 3.6 TURF MAINTENANCE

- A. Maintenance of turf areas includes proper watering and soil moisture content, fertilizing, mulching, cutting, rolling, pest and disease control, reseeding and other functions necessary to maintain a healthy, vigorous growing lawn. Maintenance will continue until lawn areas have a complete established close stand of grass.
- B. Maintenance Schedules: Provide complete maintenance specifications including general design maintenance intent of plant material and fertilizing schedule based on planting design.

### 3.7 CLEANUP AND PROTECTION

- A. As the work progresses, maintain areas in a neat, clean, orderly manner, and remove unsightly debris as necessary. At the completion of the work, sweep and clean walks, parking and other paved areas adjacent to plantings.
- B. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- C. Protect plants, lawns from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.
- D. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- E. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 32 93 00 - PLANTS

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Plants.
  - 2. Planting soils and soil amendments
  - 3. Landscape Mulches
  - 4. Tree stabilization.
  - 5. Landscape edgings.
  - 6. Tree grates.
- B. Related Sections:
  - 1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
  - 3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
  - 4. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
  - 5. Division 32 Section "Stainless Steel Trellis System" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.
  - 6. Division 32 Section "Planting Irrigations" for planting irrigation systems.
  - 7. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.
  - 8. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

1.3 REFERENCES

- A. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

#### 1.4 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Brown Trunk Height: (BTH) Indicating the height of palm trees. The Brown trunk height shall be measured from the ground line to the base of the heart leaf or emerging leaf bud.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Date of Acceptance: Date at the end of the warranty periods (as specified herein) when written acceptance is provided by the Design Consultant.
- E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- F. Finish Grade: Elevation of finished surface of planting soil (not mulch) within 1/10<sup>th</sup> of an inch. Unless other wise noted soil finish shall be:
  - 1. 2 ½" below hardscape /pavement areas
  - 2. 5" below topcut curb or planter wall
  - 3. 1" below hardscape/ pavement areas (at lawn assembly)
- G. Manufactured or Import Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- H. Native Planting Areas: Areas to be planted with California Native Plants or covered with mulches not intended for pedestrian or vehicular circulation. Native Planting areas will require special soil preparation and planting procedures to create the ecology necessary for Native Plantings.
- I. Native Soil: Existing soil found in place on the site. Soil is defined as the unconsolidated mineral or organic matter on the immediate surface of the earth which serves as a natural medium for the growth of plants.
- J. Notice of Completion: The date at the close of the Maintenance Period when the work has been completed, checked, accepted and written approval of the work has been given by the Design Consultant.
- K. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- L. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- M. Planting Area: Areas to be planted or covered with mulches not intended for pedestrian or vehicular circulation.
- N. Planting Soil: Existing, in-place surface soil or imported topsoil that is modified with soil amendments and fertilizers per the specifications to produce a soil mixture best for plant growth.
- O. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- P. Raised Planter: Planted areas that are bounded by wall or curb 12" or higher than the adjacent grade or surface. To be filled with import topsoil to the full and complete depth of the planter.
- Q. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- R. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- S. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- T. To Remain: Planting areas identified in the Drawings to be protected and maintained in place.

#### 1.5 SUBMITTALS

- A. Submittals for items shall be made in one package. If submittals are judged incomplete or non-responsive to the directions of the Design Consultant after three submittals, the Contractor shall be back-charged for the Design Consultant's costs to process additional Submittals.
- B. Submittals will be rejected without the benefit of review by the Design Consultant if they are difficult to read, incomplete or if the required information is not presented in format required.
- C. Product Data:
  - 1. For each type of product listed in Part 2 of this specification.
  - 2. Plant Materials: Include quantities, sizes, quality, and nursery sources for plant materials.
  - 3. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
  - 4. Plant Photographs: For each plant specified, include photo quality color photographs at 8 ½ x11 size format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Include a minimum of

three photographs of each species. Identify each photograph with the full scientific name of the plant, container size, height and spread, and name of the growing nursery. Review of plant photographs does not indicate acceptance of the plant material as delivered to the Project Site.

5. Palm Trees: Submit photos as noted above. Submit documentation from each nursery certifying that the trees have been inspected by a county or state agricultural agency within the last 3 months, the trees are disease and pest free and are available for sale.
6. Planting Schedule: Submit anticipated planting dates for each type of planting.
7. Delivery Slips for products included in submittal, slips should indicate quantity delivered.

D. Samples for Verification: For each of the following:

1. Organic Mulch: ¼ lb bagged samples of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: 1 lb bagged sample of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of name, source, size, and color range of the material.
3. Stone 1"-3" diameter: Submit nine stones for each type and/or size range. Label shipping container with an accurate indication of name, source, size and color range of the material.
4. Stone 3"-8" diameter: Submit three stones for each type and/or size range. Label shipping container with an accurate indication of name, source, size and color range of the material.
5. Stone over 8" diameter: Submit three photo quality color images at 8 ½ x11 size format of each required stone. Label each image with an accurate indication of name, source, size and color range of the material.
6. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

E. Qualification Data: For qualified Contractor. Include list of similar projects completed by Contractor demonstrating Contractor's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners/ contact persons. Refer to the "Quality Assurance" section Part 1 of this specification for additional information.

1. Soil Analysis Test Reports: Testing for planting soils including import Topsoil and existing or stockpiled soil to be used during backfill operations. Refer to Soil Testing section in Part 3 testing procedures. Soil testing shall be completed after rough grading operations. See Part 1 Quality Assurance for additional requirements.

2. Percolation Test Reports: Refer to Percolation Testing section in Part 3 for testing procedures. The results of the percolation testing must be submitted to the Design Consultant for review and approval.
- F. Maintenance Instructions: Contractor shall furnish for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
1. Instructions should include but not be limited to the following tasks: Fertilizing, irrigation schedule, dead heading, mulch or other inert groundcover replenishment, pruning of shrubs to maintain design intent and 3 year tree maintenance schedule.
  2. Instructions shall be submitted to Design Consultant for approval before submittal to the City and prior to the expiration of the Maintenance period.
- G. Landscape Planting Plan As built Drawings Contractor mark ups: Identifying changes to Contract Documents
- H. Warranty: Submit written warranties on the Contractor's or subcontractor's letterhead, addressed to the City. Submit warranties in duplicate and in the form shown in the General Conditions, or modified as approved by the Design Consultant to suit the conditions pertaining to the warranty. Refer to Warranty and Replacement section, Part 1 for more information.
- I. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
1. Credit MR 4.1 & 4.2, Recycled Content
  2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.6 QUALITY ASSURANCE

- A. Contractor Qualifications: A qualified Contractor whose work has resulted in successful establishment of plants.
1. Work shall be performed by a trained crew in accordance with the standards and practices related to the trade.
  2. Professional Membership: Contractor shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  3. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements." Provide client list with contact names, phone numbers and date planting was installed.
  4. License: Single entity Contractor holding a valid C-27 California Contractor's license.
  5. Contractor's Field Supervision: Require Contractor to maintain an experienced full-time supervisor on Project site when work is in progress.

6. Personnel Certifications: Contractor's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty area(s).
    - b. Certified Ornamental Landscape Professional, designated COLP.
  7. Pesticide Applicator: State licensed, commercial.
- B. Soil and Plant-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
1. Provide testing by one of the following or a comparable testing laboratory:
    - a. John Deere Landscapes
    - b. Soil and Plant Laboratory
    - c. Wallace Laboratories
- C. Soil Analysis Testing: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio (SAR), electrical conductivity (ECe), boron content, deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Supply Testing Agency with a complete copy of this specification and a copy of the project plant list and planting plan at the time of the soil testing.
  2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
  3. The soil-testing laboratory shall oversee soil sampling at the conclusion of rough grading operations; with depth, location, and number of samples to be taken per instructions from Design Consultant. A minimum of five representative samples (or as listed in the Drawings) shall be taken from varied locations for each soil to be used or amended for planting purposes.
  4. No amendments shall be applied prior to receipt of test results.
  5. Report suitability of tested soil for plant growth.
    - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for recommended quantities of soil amendments and fertilizers listed in the specifications to produce satisfactory planting soil suitable for healthy, viable plants.
    - b. Testing Agency recommendations must use the soil amendments and fertilizers listed in the specifications in their recommendations.

- c. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
  - d. If corrective measures are specified, provide retesting of soils after measures are corrected to confirm soils were successfully abated. Costs for soil testing and retesting after corrective measures are completed shall be including in the base bid price.
- 6. The Design Consultant shall recommend all changes to the amendments listed after review of the test results. Cost change for soil preparation shall be in accordance with the provisions in the General Conditions. Amounts of amendments listed in Part 3 shall be used for bidding purposes.
- D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- F. Plant Material Observation: Design Consultant may elect to observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Design Consultant retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Design Consultant of sources of planting materials fourteen days in advance of delivery to site.
- G. Preinstallation Conference: Conduct conference at Project site with the Design Consultant, Contractor and Contractor to review requirements.
  - 1. Meeting minutes from the preinstallation conference shall be the responsibility of the Contractor and shall be distributed to the parties in attendance for review and subsequent approval of conference discussion items.
  - 2. Discussion agenda items during the pre-installation shall include the Contractor's understanding and familiarity with the following:
    - a. Protection of existing trees and landscape areas
    - b. Contract grown plant material
    - c. Site materials and finishes



- d. Required submittals, samples and mock-ups.
- e. Preparation and criteria for generation of the punch list, determination of Notice of Completion and Date of Acceptance.
- f. Soil testing and percolation testing
- g. Procedures protocol for site construction observation visits.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants or within driplines of existing trees.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Plants shall not be allowed to remain on site longer than 5 days prior to planting.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

## 1.8 PROJECT CONDITIONS

- A. Field Measurements: Prior to excavation for planting or placing of plant materials, verify actual grade elevations, service and utility locations, underground and overhead lines, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. In the event of a conflict the Contractor shall notify the Design Consultant.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by the City or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
  - 1. Notify the City no fewer than two days in advance of proposed interruption of each service or utility.
  - 2. Do not proceed with interruption of services or utilities without the City's written permission.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- D. Site Draining: Established site drainage shall be maintained by the Contractor during phase of the Work. Grade areas as needed to insure proper grades and drainage as indicated on Drawings. Final finish grade shall insure positive drainage with surface drainage away from buildings, walls and toward driveways, drainlets and catch basins.
- E. Errors and Omission: Refer to errors and/or discrepancies in or between plans, specifications, lists or notes to the Design Consultant for adjustments before proceeding with the Work. The Contractor shall assume responsibility for proceeding with the Work without referring. In the event of a conflict, the Design Consultant shall interpret the meaning of the Contract Drawings and Contract Specifications and their decision shall be final.
- F. Excavation: When conditions detrimental to plant growth are encountered such as rubble fill, adverse drainage conditions or obstructions, cease planting operations and notify the Design Consultant for further direction.
- G. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

## 1.9 WARRANTY

- A. Special Warranty: Contractor agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Death and unsatisfactory growth, except for defects resulting from incidents that are beyond Contractor's control.
  - b. Structural failures including plantings falling or blowing over.
  - c. Faulty performance of tree stabilization, edgings, tree grates, improper planting, and failure to water sufficiently.
  - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - e. Damages done to plant material during construction.
2. Warranty Periods from Date of Notice of Completion:
- a. New Trees: : 12 months
  - b. Relocated Trees: 36 months
  - c. Shrubs, Vines, and Ornamental Grasses: 6 months
  - d. Ground Covers, Biennials, Perennials, and Other Plants: 6 months.
3. Include the following remedial actions as a minimum:
- a. Immediately remove dead plants within 14 days and replace unless required to plant in the succeeding planting season.
  - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  - c. Replacement plants shall be of the same size, species and variety as specified in the Drawings. Replacement includes restoration of surrounding area to match the existing conditions.
  - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

#### 1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Contractor. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
  - 1. Maintenance Period: 180 days from date of Notice of Completion.
- B. Within one week, prior to authorization start of maintenance, submit a Maintenance Schedule to the Design Consultant listing the days when maintenance crews will be on site. Include a contact person and emergency phone number.
- C. The maintenance period shall be extended when in the opinion of the Design Consultant, dead or dying plant materials, poor or unhealthy growing conditions or improper maintenance practices are evident within the maintenance period. The extended period

shall be provided at no additional cost to the City and shall be extended until the work is complete and acceptable to the Design Consultant.

#### 1.11 REJECTION AND SUBSTITUTION

- A. Products or materials, whether installed or not, not conforming to the requirements herein specified shall be considered defective, and be marked as rejected. Materials shall be removed and replaced with approved materials at no additional cost to the City.
- B. Submit written request for each proposed substitution. Provide data substantiating the request as well as a Certificate of Suitability certifying that the proposed substitution is equal or better in respects to that specified and that it will perform the function for which it is intended. Include with request required samples.

#### 1.12 SITE OBSERVATIONS

- A. Schedule and coordinate site observation visits for the following construction activities. Reviews shall be performed by the Design Consultant and notification shall be given in advance notice as noted:

	<u>Item</u>	<u>Advance Notice</u>
1.	Protection of existing plant materials	48 hours
2.	Rough grade	48 hours
3.	Soil preparation and finish grade	48 hours
4.	Inspection of plant material delivered on site.	48 hours
5.	Spotting of Trees prior to excavation of planting holes	48 hours
6.	Plant material review	48 hours
7.	Plant layout and installation	48 hours
8.	Substantial Completion Punch List	7 days
9.	Punch List Completion	7 days
10.	Maintenance Completion	7 days

### PART 2 - PRODUCTS

#### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of weeds, disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling or kinked roots will be rejected.
  - 2. Plants shall have normal well-developed, vigorous and fibrous root systems which are neither root, nor container bound.
  - 3. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Design Consultant, with a proportionate increase in size of roots or balls.
- C. Labeling: Label five plants of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.
- D. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- E. Provide healthy, weed and disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.
- F. Plants shall be grown in their container for at least six months, but not over two years.
- G. Groundcover plants grown in flats shall be healthy vigorous rooted cuttings grown in flats for at least 3 months but not over six months.
- H. Succulents: Succulents shall be acquired from a licensed nursery. Succulents shall be free of insects, mottled leaves, broken or split branches or trunks, scarring or other uncharacteristic growth patterns.

## 2.2 INORGANIC SOIL AMENDMENTS

- A. Sulfur: Pelletized, biodegradable, commercially processed and packaged, and containing a minimum of 90 percent sulfur capable of oxidizing over time and providing nutrient sulfur with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
  - 1. Acceptable Manufacturers:
    - a. "Tiger 90 CR", John Deere Landscapes (800) 233-6933
- B. Iron Sulfate: a non-staining iron with micronutrients, pelletized, slow release, environmentally safe; 40% Iron, 1% Manganese, 1% Zinc, 1% Magnesium, 6% Sulfur; 2% Humic Acids
  - 1. Acceptable Manufacturers:
    - a. "Premium Green Iron 40% Fe", Gro-Power®, Inc. (800) 473-1307
- C. Agricultural Gypsum: Minimum 90 percent calcium sulfate ( $\text{CaSO}_4$ ,  $\text{H}_2\text{O}$ ), a commercially processed and packaged gypsum, finely ground with 90 percent passing through No. 50 sieve.
- D. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

## 2.3 ORGANIC SOIL AMENDMENTS

- A. Soil Amendment: a blend of organic fractions with several degrees of breakdown rate, a long-lasting form of iron, trace elements, pH of 5.5 to 7.5, maximum salinity of 2.50 ECe, organic matter (dry weight basis) more than 90%, non-ionic wetting agent and total nitrogen content of 0.4 – 0.8%

1. Acceptable Manufacturers:

- a. "Numex Lif", John Deere Landscapes (800) 233-6933
- b. "A-1 Nutri-Gro", Hanson Aggregates/A-1 Soils

## 2.4 FERTILIZERS

- A. Pre-plant Fertilizer for plants and lawns(5-3-1) with Soil Penetrant Added. Fertilizer and soil conditioner derived from organic materials consisting of higher plant form life, composted beyond the fibrous stage. Shall not contain the following: poultry, animal or human waste, pathogenic viruses, fly larvae, insecticides, herbicides, fungicides or poisonous chemicals that would inhibit plant growth. Physical properties: A uniform "Beaded" homogenous mixture - 100.00% passing through a #4 mesh screen - a water soluble bio-degradable binder is used to insure fast breakdown.

Nitrogen	5% minimum
Phosphoric Acid	3% minimum
Water Soluble Potash	1% minimum
Humus	70% minimum
Humic Acids	15% minimum
Soluble Metallic Iron	1% minimum

Soil Penetrant: (Alkyl Naphthalene Sodium Sulfonate.) 1% minimum

Bacterial "stimulator":(Common soil and airborne organisms - aerobic, anaerobic, yeast and mold) 60,000 per 100 gram minimum

1. Acceptable Manufacturers:

- a. "Gro-Power Plus 5-3-1", Gro-Power®, Inc. (800) 473-1307

- B. Pre-plant Fertilizer for plants and lawns (6-20-20): an organic based, long lasting, non burning, slow release, free flowing, uniform in composition fertilizer, suitable for application with approved equipment, and containing the following minimum available percentages of weight of plant food with trace minerals of 2% iron (expressed metallic) and 7% sulfur (elemental), Zinc .15% and Manganese .15%.

Nitrogen	6% minimum
Phosphoric Acid	20% minimum
Soluble Potash	20% minimum

1. Acceptable Manufacturers:

- a. "Best 6-20-20 XB", John Deere Landscapes (800) 233-6933.

- C. Pre-plant Balanced Fertilizer for Phosphorous or potassium deficient soils. (12-12-12): a balanced formula with nutrients in each pellet (homogenous) to prevent streaking due to

particle segregation. Contains Sulfur and Calcium to help withstand weather extremes, improved unproductive soils and improve overall color and disease resistance.

Nitrogen	12%	minimum
Phosphoric Acid	12%	minimum
Soluble Potash	12%	minimum
Sulfur	15%	minimum
Calcium	2.1%	minimum

1. Acceptable Manufacturers:

- a. "Best Triple Twelve 12-12-12", John Deere Landscapes (800) 233-6933.

- D. Lawn Post-plant Fertilizer: (18-3-7): with 40% of the nitrogen a slow release SCU. 20% humus, 4% humic Acids, 4% sulfur, 1% iron, 0.50% soil penetrant, and soil enhancers. Nitrogen source: 5.94% Ammoniacal Nitrogen, 4.86% Nitrate Nitrogen, 5.40% Sulphur Coated Slow-Release Nitrogen, 1.08% Urea Nitrogen. Gro-Power bacterial "stimulator" included -bacteria (common soil and airborne organisms - aerobic, anaerobic,) yeast and mold, minimum 60,000 per 100 gram.

Nitrogen	18%	minimum
Phosphoric Acid	3%	minimum
Soluble Potash	7%	minimum

1. Acceptable Manufacturers:

- a. "Gro-Power Premium Hi-Nitrogen 18-3-7", Gro-Power®, Inc. (800) 473-1307

- E. Controlled Release Lawn Post-plant Fertilizer (25-5-5): Dry application, stain resistant, controlled release with polymer-coated granules, suitable for application with approved equipment.

Nitrogen (total)	25%	minimum
Ammoniacal Nitrogen	10.3%	minimum
Urea Nitrogen	14.7%	minimum
Phosphate	5%	minimum
Soluable Potash	5%	minimum
Sulfur	11%	minimum
Iron	0.9%	minimum

1. Acceptable Manufacturers:

- a. "Best Super Turf 25-5-5" as supplied by John Deere Landscapes (800) 233-6933

- F. Palm, Tropicals and Bamboo Fertilizer (9-3-9) : Controlled release nitrogen and potash with Micronutrients.

Nitrogen (total)	9%	minimum
Water Soluble Organic Nitrogen	0.92%	
Water Insoluble Organic Nitrogen	8.08%	
Phosphoric Acid	3%	minimum
Potash (total)	9%	minimum

Soluble Potash	1.10%
Slowly available potash	7.9%
Calcium	3%
Magnesium	4%
Iron	2%
Manganese	0.05%
Zinc	0.05%

1. Acceptable Manufacturers:

- a. “Gro-Power Palm Fertilizer and Tropicals (9-3-9)”, Gro-Power®, Inc. (800) 473-1307,

- G. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots. Slow release fertilizer tablets, soil conditioner, 24-month formulation with trace elements, composted organic higher plant form life and mineral matter. Shall not contain poultry, animal or human waste.

1. Nutrient Composition:

Nitrogen (total)	20%	minimum
Ammonical Nitrogen	2%	
Water Soluable Organic Nitrogen	5.3%	
Water Insoluable Organic Nitrogen	12.7%	
Phosphoric Acid	10%	minimum
Soluable Potash	5%	minimum
Calcium	3.5%	
Sulphur	2.5%	minimum
Iron (Fe)	2%	minimum
Manganese	0.05%	minimum
Zinc	0.05%	minimum
Humic Acids (derived from compost)	2.5%	minimum

2. Acceptable Manufacturers:

- a. “Gro-Power (20-10-5) Planting Tablets”, Gro-Power®, Inc. (800) 473-1307

2.5 MYCORRHIZAL SOIL CONDITIONER AND HUMIC ACIDS

- A. Mycorrhizal Inoculum / Soil Conditioner: Inoculum shall be both Endo and Ecto (granular), with consisting of propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species *Glomus intraradices*, *Glomus aggregatum*, *Glomus mosseae*, combined with other species and/or additional genera including, *Sclerocystis*, *Gigaspora*, *Scutellospora*, *Entrophospora*, and *Acaulospora*. Ectomycorrhiza include *Pisolithus* and 4 species of *Rhizopogon*. Soil Conditioner portion shall consist of organic materials consisting of higher plant form life, composted beyond the fibrous stage, to humus. Also shall have humic acids and beneficial soil bacteria strains. It shall NOT contain poultry, animal or human waste (i.e., sewage sludge), pathogenic viruses, fly larvae, insecticides, herbicides, fungicide or poisonous chemicals that would inhibit plant growth.



1. Nutrient Composition:

Ingredients	percentage (minimum)
Mycorrhizal Inoculum	6,500/55,00 propagules per lb.*
Humus	65%
Humic Acids	25%

2. Acceptable Manufacturers

- a. "GroLife Granular", Gro-Power®, Inc (800) 473-1307.

B. Humic Acids (from Leonardite) 70 .00 %

1. Nutrient Composition: Per random sample of material.

Organic matter	40.00	%
Carbon	40.00	%
Nitrogen	0.05	%
Phosphoric Acid	0.07	%
Potash	0.13	%
Sulfur	0.21	%
Magnesium	0.18	%
Calcium	0.32	%
pH	4.0	
Soluble Salts	1.8	

2. Acceptable Manufacturers

- a. "Tri-C Premium Humate" (800) 927-3311.

2.6 SOIL PENETRATING AGENT

A. Acceptable Manufacturers

1. "Sarvon", John Deere Landscapes (800) 233-6933.

2.7 PLANTING SOILS

A. Import Topsoil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of [2] percent organic material content; free of stones 1 inch or larger in dimension and other extraneous materials harmful to plant growth.

1. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0 millimeter sieve. The sodium absorption rate (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract.
2. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous

materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

3. Submit results of agricultural soils analysis testing for review and approval by the Design Consultant.

## 2.8 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: “Gorilla Hair” Redwood Bark Mulch, fibrous, stringy, dark red product that is 100% derived from Sempervirens species of the Sequoia Redwood tree.

- a. Size Range: Particle size shall be 95% passing a range from 1" to 3", with some fibers being longer than 3"

- b. Acceptable Manufacturer:

- 1) John Deere Landscapes (800) 233-6933, or equal.

2. Type: “Eco- Mulch” 100% green waste mulch, free of trash and other deleterious materials.

- a. Size Range: 3/8"-3"

- b. Acceptable Manufacturer:

- 1) Earthwise (760) 599-4156

3. Type: “Pacific Mulch: Appearance grade, composed organic forest products, free of trash and other deleterious materials, with pathogens and weeds removed by temperature treatment.

- a. Size Range: 1"-3"

- b. Acceptable Manufacturer:

- 1) John Deere Landscapes (800) 233-6933

- B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Rock Mulch. Double washed and graded to “3/8 minus” crushed stone.

- a. Size Range: as indicated on drawings

- b. Color: as indicated on drawings
- c. Acceptable Manufacturers:
  - 1) KRC (760) 744-1035
  - 2) Decorative Stone Solutions (800) 699-1878
  - 3) Southwest Boulder (800) 540-1147

## 2.9 FILTER FABRIC

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

## 2.10 PESTICIDES

- A. Prior to using pesticides, contractor shall review procedures with the Design Consultant and obtain written approval prior to using pesticides.
- B. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- C. Contractor shall be licensed by the County to perform pesticide applications.
- D. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
  - 1. Acceptable Manufacturers:
    - a. Treflan
    - b. Surfland
    - c. Eptan
- E. Post-Emergent Herbicide: Round-up

## 2.11 TREE STABILIZATION MATERIALS

- A. Stakes and Guys:
  - 1. Wood Stakes: Shaved, sound, new lodgepole pine, free of knots, branches, holes, cross grain, and other defects, of the length indicated on the Drawings, pointed at one end.
    - a. Stakes for 24" box trees or smaller shall be no less than 10 feet in length and 2" in diameter.
    - b. Stakes for 26" box trees and larger shall be no less than 12 feet in length and 3" in diameter.

c. Acceptable Manufacturers:

- 1) Villa Root Barrier, Inc. (800) 654-4067

2. Tree Ties: Flexible non-deteriorating self fastening, black vinyl ties of sizes required to adequately support trees.

a. Acceptable Manufacturers:

- 1) Gro-Straight ties
- 2) Cinch-Ties

3. Guying Materials: 3/16" braided steel cable, 6" open turnbuckles, ½" pvc pipe, Duckbill Anchors or 2 x 4 x 24" redwood deadman or approved equal.
4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

## 2.12 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Basis-of-Design Product: Subject to compliance with requirements, provide "Duraedge" or comparable product by one of the following:
  - a. Russell, J. D. Company (The).
2. Steel curbing shall be ¼" thick by 5" deep with 7 stakes per section, painted at the factory.
3. Stakes: Tapered steel, a minimum of 14 inches long.
4. Accessories: Standard tapered ends, corners, and splicers.
5. Finish: Painted Steel
  - a. Paint Color: Black

## 2.13 AERATION TUBES

- A. Tubes: 4" dia. Schedule 40 PVC perforated pipe cut to lengths as shown on the Drawings.

1. Acceptable Manufacturer: Pacific Plastics, Inc. (714)-990-9050.

- B. Grates: 4" dia.

1. For Bark Chip Planting areas: round, black, plastic atrium drain grates;
2. For Lawn areas: round, green, flat plastic drain grates;

3. For Gravel and stone mulch planting areas: round, brown, flat plastic drain grates.
  4. Acceptable Manufacturer: National Diversified Sales (NDS).
- C. Filter fabric "sock": Spunbond, Tytar 3341, Geoscape Landscape Fabric - 2.5 oz., Commercial Grade"
1. Acceptable Manufacturer: ADS (800) 821-6710.

#### 2.14 ROOT BARRIER

- A. Root barrier shall be "Tytar Biobarrier" root control root fabric with Treflan, 39" width unless otherwise noted in the plans.
1. Acceptable Manufacturer: Dow Elanco., John Deere Landscapes (800) 233-6933.
- B. Root barrier shall be model #LB18-2 (for curbs and walls) or #LB12-2 (for paving). The barriers shall be black, injection molded panels, of 2mm wall thickness in modules 61cm long by 30cm or 46cm deep; manufactured with 50% post consumer recycled polypropylene plastic with added ultraviolet inhibitors; recyclable. Each panel shall have: not less than 4 molded, integral, vertical, root deflecting ribs of a minimum 1.5mm thickness protruding 13mm at 90° from the interior of the panel, spaced 15cm apart. Barrier shall have a double top edge consisting of two parallel, integral, horizontal ribs at the top of the panel of a minimum 1.5mm thickness, 9.5mm wide and 6.5mm apart with the lower rib attached to the vertical root deflecting ribs.
1. Acceptable Manufacturer: Deep Root Partners, 81 Langton St, Suite 4 San Francisco, CA 94103 (800-458-7668).

#### 2.15 EROSION CONTROL MATERIALS

- A. Erosion Control Jute Mesh: Jute mesh shall be new and shall be of a uniform, open, plain-weave mesh. The mesh shall be made from unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than half its normal diameter. Jute mesh shall be furnished in rolled strips and shall conform to the following provisions.
1. Width - 1200 mm with a tolerance of  $\pm 25$  mm
  2. Warp ends - 78, minimum, per width.
  3. Weft ends - 44, minimum, per meter
  4. Mass - 0.57 to 0.63-kg/m
  5. Include manufacturer's recommended steel wire staples, U- shaped, 8 gauge, 8 inches long.
  6. Acceptable Manufacturer - Anti-Wash Geojute, Belton Ind. Dist. By John Deere Landscapes (800) 233-6933.
- B. Provide at slopes 3:1 or greater or as otherwise indicated in the Drawings.

2.16 MISCELLANEOUS PRODUCTS

- A. Wood Pressure-Preservative Treatment: AWP C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
  - 1. Acceptable Manufacturer: Wilt Pruf
- C. Burlap: Non-synthetic, biodegradable.
- D. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- E. Tree Protection Material: Enclosure: 5' tall chain link fence with a minimum 1½" dia. posts and 1" top and bottom rails. Caution tape, or twine and flags are not acceptable.
- F. Vine Ties: Vine ties shall be silicone epoxy type, with wire clasp for vines.
  - 1. Acceptable Manufacturers: Dexol "Stick-n-ty"

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. No work under this section shall commence until submittals have been reviewed and approved. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
  - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

- D. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Design Consultant and replace with new planting soil.

### 3.2 SOILS TESTS

- A. At the conclusion of rough grading, collect soil samples in the locations indicated on the plans and as described in Part 1 Quality Assurance. Submit the samples to an approved agricultural soils laboratory for testing.
- B. Submit the test results and laboratory recommendations to the Design Consultant for review. No amendments shall be applied prior to receipt of test results. Test recommendations shall include the amendments listed in this specification.
- C. The Design Consultant shall recommend changes to the amendments and/or procedure listed herein, after review of the test results.
- D. Costs for testing and retesting the soil shall be included in the base bid.
- E. Soil testing is considered a long lead item, retesting may be required to confirm that recommended remediation measures were successful and soil test results are within the acceptable ranges for plant growth. The time frame for this work shall not be shortened because adequate time was not allowed for testing and retesting of the soils. The soils will need to be retested until an acceptable test result is attained.
- F. Cost change for soil preparation work shall be in accordance with the provisions of the General Conditions. Refer to Part 1 Quality Assurance for additional requirements.

### 3.3 WEED CONTROL

- A. Prior to commencement of the planting operations, remove weeds including the roots, remove existing plant material including stumps designated not to remain, dispose of cleared and grubbed material at a legal refuse site.
- B. Prior to using herbicides, review procedures with the City, and obtain written approval. Herbicide applications requiring government or agency approvals shall be performed by an operator licensed by the County. Protect existing plant material on site and on adjacent properties from exposure to herbicides and equipment.

### 3.4 PREPARATION AND LAYOUT

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Design Consultant's acceptance of layout before excavating or planting. Make minor adjustments as required.

### 3.5 EROSION CONTROL

- A. Install jute mesh on slopes over 3:1. After grading, clearing and grubbing that is required, fine-grade the sloped planting areas to receive jute mesh, removing surface rocks and debris greater than 2" in diameter.
- B. Jute mesh shall be installed loosely on the slopes. Longitudinal seams of the jute mesh shall be at right angles to the slope contour lines. The installed mesh shall fit the soil surface contour and shall be held in place by 9 inch long, 11 gage (minimum) steel wire staples driven vertically into the soil at approximately 24-inch spacing. Jute mesh strips shall overlap the adjacent jute mesh a minimum of 6 inches. Ends of strips shall be buried into the soil a minimum of 6 inches.

### 3.6 SOIL PREPARATION

- A. Proceed with this part of the work only after soil test analysis recommendations have been approved by the Design Consultant.
- B. Apply 50 lbs/1,000 SF of Gypsum to subgrade prior to tilling.
- C. Rip or loosen native soil or subgrade for the entire extent of planting areas to a minimum depth of 18 inches without adding soil conditioner.
- D. Remove stones larger than 1 inch in dimension and sticks, roots, rubbish, and other extraneous matter to a depth of 18" below finish grade and legally dispose of them off City's property.
- E. Prepare areas within the driplines of existing trees by hand, do not use mechanical tillers.
- F. Spread soil amendments, remaining gypsum and other amendments over planting areas and mechanically till and blend to a depth of 6 inches.
- G. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
- H. Use the soil amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests noted Part 3 Soils Tests.

Amendments	Rate or Quantity/1,000 SF.
Soil Amendment	4 cubic yards
Gypsum	100 lbs.
Pre-Plant Fertilizer	150 lbs.
Soil Sulfur	10 lbs.
Iron Sulfate	10 lbs
Mycorrhizal Soil Conditioner	20 lbs.
Humic Acid	50 lbs.
Soil Penetrating Agent	16 oz.

- I. Float smooth and compact soil preparation areas to 85% relative dry density, maintain positive drainage, flow lines, and swells to area drains, fine grade to within plus or minus 0.10 foot of the grades shown on the Drawings.



- J. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- K. Before planting, obtain Design Consultant's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- L. Application of Mycorrhizal Fungi Soil Conditioner: Per the manufacturer's recommendations, broadcast dry product uniformly over prepared soil at application rates listed in the specifications.

### 3.7 PRE PLANT WEED CONTROL

- A. Clear and remove existing weeds at least one-inch below the soil surface.
- B. Fertilize areas to receive planting with a 46-0-0 NPK commercial fertilizer at the rate of ½ lb. per 1,000 square feet.
- C. After fertilization, irrigate the soil thoroughly and continuously at the equivalent of four inches of water distributed over a fourteen – day period. The application of water shall be applied to the soil as needed to gradually soak through the soil profile and not allowed to run-off the surface. Employ a specific watering duration and frequency program designed to germinate residual weeds.
- D. After sufficient weed germination is present, apply non-selective, post-emergent contact herbicide, in strict accordance to the Manufacturer's directions. Protect and buffer surrounding properties, buildings, and vegetation from overspray, as required.
- E. Allow for a sufficient time period to ensure that the weeds are dead and the herbicide has dissipated, per the Manufacturer's recommendation.
- F. Water planting areas thoroughly and continuously for a period of one week after the application of the herbicide. Discontinue the watering process for one day prior to the second application of the herbicide. Apply a second application of the herbicide. Avoid irrigation for a minimum of four days after the second application for effective weed kill.
- G. After the second application and waiting period, water planting areas thoroughly and continuously for three consecutive days to saturate upper layers of the soil prior to commencing planting operations.
- H. Dead weeds shall be cleared and removed prior to planting.
- I. Maintain a weed-free Project Site until final acceptance by the Diocese, utilizing mechanical, chemical or manual treatment.

### 3.8 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately two times as wide as ball diameter for container-grown stock.
  2. Do not excavate deeper than depth of the root ball less one inch, measured from the root flare to the bottom of the root ball.
  3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  5. Maintain supervision of excavations during working hours.
  6. Keep excavations covered or otherwise protected when unattended by Contractor 's personnel.
  7. If subdrainage is shown on Drawings or required under planting areas, coordinate planting operations with installation of subdrainge.
- B. Obstructions: Notify Design Consultant if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- C. Drainage: Notify Design Consultant if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- D. Subsoil and topsoil removed from excavations may be amended and used as planting backfill mix.

### 3.9 PERCOLATION TESTING

- A. Locate and prepare the percolation test pits where indicated on the Drawings, and as described herein.
- B. Excavate the pits as described under the Excavation for Trees and Shrubs section, remove loose material, and fill the pits with six inches of water. After 12 hours refill with the same amount of water. Six hours after the second filling, inspect the pits with the Design Consultant and document locations where water remains in the pit.
- C. If percolation problems occur, provide means and methods for correcting said problems. Planting operations at the locations identified shall be suspended as necessary or as directed by the Design Consultant. Payment for corrective work shall be in accordance with the provisions of the General Conditions. Proceeding with the work without written approval, does not entitle the Contractor to additional compensation for corrective work.
- D. If percolation problems occur, drill 8-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 5 feet below the bottom of rootball whichever is less, and backfill with drainage gravel and 4" diameter perforated PVC pipe open to below. Cap with appropriate grate, see AERATION TUBES Part 2.

### 3.10 TREE, SHRUB, GROWDCOVER AND VINE PLANTING

- A. To leach saline and sodic salts from the soil, fill excavations with water and allow to percolate away before positioning trees and shrubs.
- B. Notify the Design Consultant of conditions where hardpan, adobe clay, or inadequate subgrade compaction are encountered. Planting operations at the locations identified shall be suspended pending corrective action.
- C. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- D. Remove injured roots by cutting cleanly; do not break.
- E. Use the soil amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests noted Part 3 Soils Tests.

1. Backfill mixture for plants except palms shall be thoroughly blended, consisting of the following:

Soil Amendment	1	part
Existing Soil	3	parts
Iron Sulfate	2	lb/cy of mix
Soil Sulfur	1	lb/cy of mix
Gypsum	25	lb/cy of mix
Pre-plant Fertilizer (5-3-1)	18	lb/cy of mix
Mycorrhizal Inoculum Soil Conditioner	10	lb/cy of mix
Humic Acid	3	lb/cy of mix
Soil Penetrating Agent	1-2	oz./Gallon

- F. Place planting tablets in the planting pits at the following rates:

Plant Size	Quantity	Tablet Size
liner and flat size plant	1	5 gram
1 gallon container	1	21 gram
5 gallon container	2	21 gram
15 gallon container	3	21 gram
box specimen	2	21 gram for each 12" of box size

- G. Set container stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades or as indicated in the Drawings.
  1. Use planting soil listed above for backfill.
  2. Do not use planting stock if root ball is cracked or broken before or during planting operations.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly

before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts listed in the specifications. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole and do not place plant tablets in direct contact with the rootball.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

### 3.11 AERATION TUBES

- A. Wrap tubes with the fabric and set plumb in opposite corners of the planting pit. Place gravel and backfill mix as shown on the Drawings. Tubes to remain open to below. Knot filter fabric sock to prohibit sediment from getting into tubes. Cut tubes to 2" above finish grade and cap with a drain grate.

### 3.12 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

### 3.13 TREE STABILIZATION

1. Upright Staking and Tying: Per the Drawings.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

### 3.14 VINE STAKING

- A. Vine Staking: Remove nursery stakes or trellis from vines, and spread or "fan out" the branches in a symmetrical form against the adjacent walls, columns, fences, or structures. Attach the branches as necessary with vine ties. Use clear silicone to attach ties to masonry, concrete, or stucco, and 4d galvanized nails to wood fences.

### 3.15 ROOT-BARRIER INSTALLATION

- A. Install root barrier where trees are planted within 60 inches of paving or other hardscape elements, such as walls, curbs, and walkways unless otherwise shown on Drawings.
- B. Align root barrier vertically and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
- C. Install root barrier continuously for a distance of 60 inches in each direction from the tree trunk, for a total distance of 10 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.

1. Position top of root barrier at finished grade of soil unless otherwise directed. Adhere root barrier product in place using fabric pins or other measures. Secure fabric every two feet for entire length of installation. Adhere to edging or hardscape.
2. Overlap root barrier a minimum of 12 inches at joints.
3. Do not distort or bend root barrier during construction activities.
4. Do not install root barrier surrounding the root ball of tree.

### 3.16 PLANTING AREA MULCHING

- A. The entire limit of all planting areas shall receive landscape mulch unless otherwise specifically stated. Note that the drawings do not show mulch hatch patterns underneath plant symbols for graphic purposes only. The intention is that the entire planted area including the areas underneath the planting symbols shall receive the same landscape mulching.
- B. Bark Mulch: At the completion of the planting work, rake smooth the areas indicated on the Drawings, and spread a 3" layer of mulch over the areas. Within 3' of flatwork, headers, curb, and mow edges, taper or reduce the depth to 2". Keep mulch 2 feet away from tree trunks and 4-6" away from shrub stems.
- C. Gravel/D.G. Mulch: At the completion of the planting work, rake smooth the areas indicated on the Drawings, and spread a 3" layer of gravel/DG. over the areas.
- D. Stone Mulch: At the completion of the planting work, rake smooth the areas indicated on the Drawings, and spread a layer of stone over a full depth 3" layer of Decomposed Granite mulch. Depth of rock mulch shall be as indicated on the Drawings or 1 ½ times the size of the largest stone size. Keep mulch 2 feet away from tree trunks and 4-6" away from shrub stems.

### 3.17 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

### 3.18 TREE GRATE INSTALLATION

### 3.19 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever

possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.20 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with City's operations and others in proximity to the Work. Notify Design Consultant before each application is performed.
- B. Written permission is required.
- C. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

### 3.21 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

### 3.22 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off property.

END OF SECTION

## SECTION 32 94 46 - STAINLESS STEEL TRELLIS SYSTEM

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

A. Section includes:

1. Vertical wire ropes.
2. Horizontal wire ropes.
3. Wire rope grid.
4. Wire rope web net.
5. Rectangular grid of vertical wire ropes and horizontal rods.
6. Vertical wire ropes attached to truss frames at top and bottom.
7. Rectangular grid of vertical wood rods and horizontal stainless steel rods.
8. Wire rope column enclosures.

B. Related sections:

#### 1.2 RELATED SECTIONS

1. Division 32 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
2. Division 32 Section "Plants" for plant material to grow on trellis system
3. Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS": LEED Requirements.

#### 1.3 REFERENCES

- A. American Iron and Steel Institute (AISI) - Steel Product Manual; Stainless and Heat Resisting Steel.
- B. ASTM A 276 - Stainless and Heat-Resisting Steel Bars and Shapes.
- C. ASTM A 380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.
- D. ASTM A 492 - Specification for Stainless Steel Rope Wire.
- E. ASTM A 555 - Stainless Steel Wire.

- F. ASTM A 582 - Specification for Free-Machining Stainless and Heat-Resisting Steel Bars.
- G. ASTM B 912 - Specification for Passivation of Stainless Steels Using Electropolishing.
- H. ASTM F 1145 - Specification for Turnbuckles, Swaged, Welded, Forged.
- I. MIL-C-5688 - Pre-Stretching and Proof-Testing of Wire Rope Assemblies.
- J. US Green Building Council (USGBC), [www.usgbc.org](http://www.usgbc.org)

#### 1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Structural Requirements: Provide stainless steel trellis systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated on the Drawings:
  - 1. Components: Design and size to withstand dead and live loads of components, plants, rain, snow and ice and loads caused by positive and negative wind pressure acting normal to plane of trellis as calculated in accordance with applicable code.
- B. Trellis systems shall be designed, fabricated, and installed to accommodate expansion and contraction of metal components without causing undue stress, buckling, opening of joints, and distortion.
- C. Design supports and hardware to withstand loads encountered without excessive deflection or distortion when cables are tensioned to required amounts required to conform to applicable building codes.

#### 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards. Provide list of fittings being provided with descriptions, load capabilities, and either photographs or drawings for each type.
- C. Shop Drawings: Submit Shop Drawings for fabrication and installation. Include the following:
  - 1. Plans, elevations, and detail sections.
  - 2. Indicate materials, methods, finishes, fittings, fasteners, anchorages, and accessory items.
  - 3. Provide setting diagrams and templates for anchorages, sleeves, and bolts to be installed by others.
  - 4. Where materials or fabrications are indicated to comply with design



loadings, include material and safety factor properties, and other information needed for structural analysis.

- D. Verification Samples: Two samples representing actual products and finishes as follows:
  - 1. Wire rope with fitting, minimum size 12 inches (300 mm) long.
  - 2. Rods, minimum size 12 inches (300 mm) long.
  - 3. Typical fittings.
- E. Installation Instructions: Manufacturer's printed installation instructions.
- F. Operation and Maintenance Data: Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
- G. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- H. LEED certification product data as specified in Division 1, Section 01 81 13, "SUSTAINABLE DESIGN REQUIREMENTS", for the following LEED credits:
  - 1. Credit MR 4.1 & 4.2, Recycled Content
  - 2. Credit MR 5.1 & 5.2, Regional Materials, Manufactured & Harvested / Extracted Locally

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturer of stainless steel wire rope, fittings, and other stainless steel components with 10 years minimum successful experience.
- B. Contractor Qualifications: Experienced in performing work of this section that has specialized in installation of work similar to that required for this project.
- C. Mock-Up: Provide a mock-up for evaluation of preparation techniques and installation workmanship.
  - 1. Locate in areas designated by Design Consultant.
  - 2. Size: Minimum of 10 SF (1 sm).
  - 3. Do not proceed with remaining work until workmanship is approved by Design Consultant.
  - 4. Rework mock-up as required to produce acceptable work.
  - 5. Retain mock-up during construction as quality standard.

6. Remove and legally dispose of mock-up when no longer needed.
  7. Incorporation: Incorporate mock-up into final construction.
- D. Preinstallation Meetings: Conduct meetings including Contractor, Design Consultant, fabricator, Contractor and other subcontractors whose work involves cable trellis system to verify project requirements, framing and support conditions, mounting surfaces and manufacturer's installation. Comply with Division 1 requirements.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Handle and store products according to manufacturer's recommendations. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- C. Exercise care not to scratch, mark, dent, or bend metal components during delivery, storage, and installation.

**1.8 PROJECT CONDITIONS**

- A. Verify actual openings by field measurements before fabrication; show recorded measurements on shop drawings.
- B. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Acceptable Manufacturer:
  1. Jakob, Inc., Toll Free Tel: 866-215-1421
  2. Carl Stahl DécorCable
  3. Feeney Architectural Products
  4. Or approved Equal
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.
- C. Provide cable, materials, fittings and components from a single manufacturer.

**2.2 ASSEMBLIES**

- A. Provide Jakob, Inc. INOX Line stainless steel climbing plant trellis structures and mounting as indicated on the Drawings. Manufacturer shall engineer and fabricate

components and assemblies for installation.

- B. Green Facades: Stainless steel climbing plant trellis structure and mountings.
  - 1. Purpose: Mounted on facades as a training system for plants as indicated on Drawings.
  - 2. Assembly: Column greening system.
  - 3. Assembly: Greening barrier rod system.
  - 4. Assembly: Greening barrier wooden rod system.
  - 5. Assembly: Webnet trelliswork system.
  - 6. Assembly: Trelliswork system.
- C. Netting Infill: Pliable, transparent netting arrays made of AISI 316 stainless steel wire rope.
  - 1. Product: Webnet as manufactured by Jakob, Inc.
  - 2. Purpose: Trellis infill.
  - 3. Material:
    - a. AISI 316 stainless steel Wire Rope:
    - b. Stainless Steel Fittings:
    - c. Stainless Steel Fasteners:
    - d. Matching End Connectors:

## 2.3 WALL MOUNTING SPACERS/BRACKETS

- A. Provide wall mounting spacers, brackets and fittings required for attachment and connection to the structure and for support of stainless steel wire rope, wire netting, metal rod and wood rod infill as indicated on the Drawings.
- B. Spacer Clearance and Load:
  - 1. Wall Clearance: per manufacturer recommendations
  - 2. Design Lateral Force: per manufacturer recommendations
  - 3. Spacer layout as selected by manufacture to suit application and design requirements specified.
- C. Mounting Types: Fabricate from AISI Type 316 and 316L stainless steel complying with ASTM F 1145; INOX Line anchors as manufactured by Jakob, Inc. Provide sizes and types as required to meet project design conditions specified

and indicated on Drawings including:

1. Through Hole in Wood: Headless screw with nut and check nut on the back and a from ring nut with support washer on the front.
  2. Screw-In Nut for Wood: Internal threaded device that accepts the threaded rope holder or headless screw device.
  3. Perforated Hollow Wall Anchor: Masonry or concrete anchor set with two-component adhesive with internal threads to accept threaded rope holder or headless screw device.
  4. Bolt Anchor with Internal Thread: Expansion bolt for concrete with internal threads to accept threaded wall fittings.
  5. Externally Insulated Facades: Expansion bolt for concrete with insulated support tube spacers and internal threads to accept externally threaded wall fittings.
  6. Shop applied swaged rope ends: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
- D. Stainless Steel Bars and Shapes: Type 316 stainless steel conforming to ASTM A 276. Provide sizes and shapes as required to meet project design conditions specified and indicated on Drawings.

#### 2.4 WIRE ROPE

- A. Material: ASTM A 492 and ASTM A 555, Type 316 stainless steel. Fabricate wire rope with integral colored filament designating specific manufacturer.
- B. Type 1: Per manufacturer recommendations
- C. Length: Provide wire rope tendons in lengths indicated on Drawings and approved shop drawings.
  1. Provide optimum adjustment in both directions by calculating final tendon lengths with allowance for tensioning fittings with 2/3 open and with 1/3 of thread length engaged.
  2. Measure tendon length from center of pin to center of pin, or center of eye to center of eye.

#### 2.5 STAINLESS STEEL RODS

- A. Rod spindles: Solid stainless steel rods, AISI Type 316 complying with ASTM A 276.
- B. Size:
  1. Diameter: 5/32 inch (4 mm).

2. Lengths as indicated on the Drawings.

C. Rod termination:

1. Cut on ends.

2.6 FITTINGS

- A. Provide fittings required for attachment and connection of stainless steel wire rope, wire netting, metal rods and/or wood rod infill to support framework and substrates.

B. Fitting minimum breaking strength:

1. As selected by manufacture to suit application and design requirements specified.

- C. Types: Fabricate from AISI Type 316 and 316L stainless steel complying with ASTM F 1145; INOX Line Fittings as manufactured by Jakob, Inc. Provide sizes and types as required to meet project design conditions specified and indicated on Drawings and reviewed shop drawings including:

1. Shop applied swaged rope ends: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
2. Screwed rope ends for on-site assembly: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
3. Clamps: Ring clamps, cross clamps, wire rope clamping cones, and connecting wire rope clamps.
4. Post fittings: Straight, angled, and spherical
5. Anchoring systems: Studs, clevis, eye end, eye bolt, slotted, spacer baskets, radial clevis holder, cross clamp with support disk, slotted rope deflector, ball cage.

- D. Accessories: Provide threaded couplings, tensioning screws, cover disks, eye bolts, eye nuts, carabineers, shackles, clips, welded rings, screws, washers, lock nuts, hexagonal nuts, dome nuts, wall anchors, screws, and wire end caps as required to complete the installation.

2.7 FINISH

- A. After fabrication, clean and de-scale stainless steel wire rope, fittings, and other components in accordance with ASTM A 380.
- B. Finish components with AISI No. 4 brushed satin finish in accordance with ASTM B 912.

2.8 FABRICATION

- A. Tolerances: Verify dimensions on site prior to shop fabrication.
- B. Fabricate stainless steel in accordance with AISI Steel Product Manual and the manufacturers requirements.
- C. Shop fabricate to designs indicated on Drawings and to meet performance requirements specified.
- D. Shop fabricate fittings, interfacing parts and assemblies so that field cutting adjustments are not necessary.
- E. Coordinate requirements, dimensions and spacings of trellis system to ensure required factory drilled holes in supporting framework are correctly located.
- F. Make exposed joints butt, flush, and hairline.
- G. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Before beginning installation, verify that conditions installed under other sections are acceptable for installation of cable trellis systems in accordance with manufacturer's installation instructions.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate Sections.
- C. Verify supporting system for stainless steel wire rope trellis is prepared for attachment of anchors, fittings, wire rope, and wire netting and transfer of calculated loads.
- D. If conditions are the responsibility of another Contractor, notify Design Consultant of unsatisfactory preparation before proceeding.

#### 3.2 PREPARATION

- A. Verify alignment, support dimensions, and tolerances are correct.
- B. Inventory components to ensure required items are available for installation. Inspect components for damage. Remove damaged components from site and replace.

#### 3.3 INSTALLATION

- A. Install wire rope trellis system in accordance with manufacturer's instructions and the approved shop drawings.
- B. Provide anchorage devices and fittings to secure to in-place construction; including threaded fittings for concrete inserts, toggle bolts and through-bolts.

- C. Install infill plumb, level, square, and rigid without kinks or sags.
  - D. Anchor trellis system to mounting surfaces as indicated on the Drawings.
  - E. Separate dissimilar materials with bushings, grommets or washers to prevent electrolytic corrosion.
  - F. Use manufacturer's supplied cable hardware.
  - G. Ensure cables are clean, parallel to each other, and without kinks or sags.
  - H. Tension cable with hand or hydraulic equipment so that no slack is visible.
  - I. After final adjustment provide tamper resistant Loctite materials on fittings.
- 3.4 ADJUSTING AND CLEANING
- A. Adjust wire rope tension and connecting hardware.
  - B. Remove temporary coverings and protection of adjacent work areas. Clean installed products in accordance with manufacturer's instructions before the City's acceptance.
  - C. Do not use abrasive cleaners.
  - D. Remove from project site and legally dispose of construction debris associated with this work.
- 3.5 PROTECTION
- A. Protect installed products until completion of project.
  - B. Touch-up, repair or replace damaged products before Substantial Completion.
  - C. Protect installed products and finished surfaces from damage during construction.
  - D. Replace defective or damaged components as directed by Design Consultant.

END OF SECTION

# **DIVISION 33**

## **UTILITIES**



SECTION 33 11 00 - WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Requirements: Provide water distribution system, complete, as indicated on the Drawings or inferable therefrom and/or as specified in accordance with the Contract Documents.

1.2 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's specifications and installation instructions for each material. Include certification or other data verifying compliance with required characteristics. Indicate by transmittal form that copy of each has been distributed to the Installer.
- B. Test Reports: Submit certified Test Reports showing compliance of the following items in accordance with Section General Conditions.
  - 1. Laboratory test for bedding and trench stabilization materials.
  - 2. Concrete design mix.
  - 3. Compression tests.
  - 4. Water Test Reports: Submit results of water sample tests by State or local health authorities

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - 2. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
  - 3. The Contractor shall have one copy of the Standard Specifications at the job site.
  - 4. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- E. NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping.
  - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

- a. The lead content for domestic water systems shall be not more than 0.2 percent in respect to solder and flux and not more than a weighted average of 0.25 percent in respect to the wetted surface of pipes and pipe fittings, plumbing fittings and fixtures. Testing and listing of products to meet NSF/ANSI 61 Annex G and Section 116875 of the California Health and Safety Code.

#### 1.4 PROJECT CONDITIONS

- A. 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 not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without ARCHITECT's written permission.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prevent damage to materials during loading, transportation, and unloading. Store equipment with moving parts off ground on platforms or skids.

#### 1.6 COORDINATION

- A. Coordinate connection to water main with utility company.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2 PIPE AND FITTINGS

- A. PVC, Schedule 40 (NPS 1/8 to NPS 3 1/2): ASTM D 1785. Suitable for potable water distribution and manufactured in compliance with NSF Standards.
  1. Fittings: PVC, Schedule 40 Socket Fittings: ASTM D 2466.

#### 2.3 VALVES

- A. AWWA, UL/FM Cast-Iron, Gate Valves:
  1. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509 and UL/F.M. approved, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    - a. Minimum Working Pressure: 200 psig.
    - b. End Connections: Flanged, push-on rubber gasketed, or mechanical joint, as required.

- c. Interior Coating: Complying with AWWA C550.

## 2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately 5-inch diameter barrel. Fabricate valve box cover to fit snugly to prevent displacement by traffic.
  - 1. Operating Wrenches: Steel tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- B. Vertical-Type Indicator Posts: UL 789, FM-approved, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve with tamperproof electrical supervisory switch for connection to the fire alarm control panel system.

## 2.5 VALVE APPLICATION

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
  - 1. Where specific valve types are not indicated, the following requirements apply:
    - a. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated, gate valves with valve box.
    - b. Underground Valves, NPS 4 and Larger, for Vertical-Type Indicator Posts: UL/FM, Cast-iron, nonrising-stem gate valves with indicator post.

## 2.6 CORROSION-PROTECTION ENCASEMENT FOR PIPING

- A. Polyethylene Encasement for Underground Ductile-Iron Pipe and Fittings: Polyethylene encasement of 8 mils thickness shall conform to AWWA C105. Joint tape shall be self sticking PVC or polyethylene, 8 mils thick.
- B. Fusion-Bonded Epoxy Coatings for Ductile-Iron and Gray-Iron Fittings: Epoxy coating shall conform to AWWA C116.

## 2.7 WATER METERS

- A. Water meter(s) indicated on drawings shall be installed by the local water purveyor for the area, unless noted otherwise.

## 2.8 BACKFLOW-PREVENTION DEVICES

- A. General: FM Approved, AWWA, UL Classified, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.
  - 1. Working Pressure: 175 psi minimum, unless otherwise indicated.
  - 2. Interior Components: Corrosion-resistant materials.
  - 3. Exterior Components: Assembly shall be provided with flanged connections, galvanized cast-iron or epoxy coated construction.

- B. Double-Check-Detector Assembly Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks; two positive-seating check valves; and bypass with displacement-type water meter, valves, and double-check backflow preventer. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examination: Examine substrates, adjoining construction and conditions under which Work is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected

### 3.2 PREPARATION

- A. Field Measurements: Verify dimensions before proceeding with Work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for accuracy of such measurements and precise fitting and assembly of finished work.

### 3.3 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
  - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - 3. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.
  - 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - 5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

### 3.4 PIPING INSTALLATION

- A. Project site water lines shall terminate approximately 5 feet from buildings, unless otherwise indicated on Drawings. Install temporary cap or plug terminals for future connection to building.
- B. Bury piping with depth of cover over top at least 36 inches, unless otherwise indicated.
- C. Comply with NFPA 24 for fire-service-main piping materials and installation.
- D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F. Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports for all lines NPS 3 or greater.

- H. Water Main Connection: Arrange and pay for tap in the water main, water meter, and all associated fees from the water purveyor.

### 3.5 CLEARANCE OF WATER LINE

- A. Building or Structure: 2 feet minimum horizontal separation.
- B. Sewer crossing:
  - 1. Typical Conditions: Lay water mains over sanitary sewers to provide vertical separation minimum 3 feet.
  - 2. Unusual Conditions: If above separation cannot be met, for sewers less than 3 feet below the water pipe, use the following:
    - a. Install water line with all joints located at least 4 feet from each side of the sewer pipe.
    - b. Sewer pipe encased in 6 inches concrete around pipe, and extend 4 feet either side of water main.
- C. Parallel to Sewer Line: Water line shall not be installed in a common trench with the building sanitary sewer unless both of the following requirements are met:
  - 1. The bottom of the water pipe, at all points, shall be at least 12 inches above the top of the sewer.
  - 2. The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a minimum clear horizontal distance of at least 12 inches from the sewer.

### 3.6 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches for all lines NPS 3 or greater. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  - 3. Fire-Service-Main Piping: According to NFPA 24.
  - 4. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.7 VALVE INSTALLATION

- A. Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. Vertical-Type Indicator Post Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

### 3.8 BACKFLOW-PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers with relief drain in vault or other space subject to flooding.
- C. Do not install bypass piping around backflow preventers.

- D. Support 3-inch and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.
- E. Access and clearance shall be provided for the required testing, maintenance and repair. Access and clearance shall require a minimum of 1 foot between the lowest portion of the assembly and grade or platform.
- F. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

### 3.9 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. UL/FM-Type Fire Hydrants: Comply with NFPA 24.

### 3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections of types and features indicated.
- B. Install ball drip valves at each check valve for fire department connection to mains.

### 3.11 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for tape specifications.

### 3.12 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than 150 psi. Examine all exposed pipe, joints, fittings and accessories during the test period. Replace or repair defective portions of the system, and repeat tests until results are satisfactory.
  - 1. Allowable leakage shall be as specified in AWWA C-600, Table 3.
- C. Prepare reports of testing activities.

### 3.13 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:
    - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours, or

- b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
  - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION

## SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
  - 1. Cleanouts.
  - 2. Precast concrete manholes.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

#### 1.3 SUBMITTALS

- A. Manufacturer's product data for pipe and fittings.
- B. Field quality-control test reports.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

#### 2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

#### 2.3 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

#### 2.4 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.



2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

## 2.5 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: 48 inches, unless otherwise indicated.
  2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  3. Base Section: 6-inch minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  4. Riser Sections: 4-inch minimum thickness, and of length to provide depth indicated.
  5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
  8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
  9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  10. Grade Rings: Reinforced concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
  11. Manhole Frames and Covers: Ferrous; 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 cast into cover, using wording "SANITARY SEWER."
    - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

## 2.6 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
1. Top-Loading Classification: Light duty.
  2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, 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: 3250 psi minimum, with 0.45 maximum water/cementitious materials ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3250 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
  - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: 2 percent through manhole unless otherwise noted.
  - 2. Benches: Concrete, sloped to drain into channel.
    - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3250 psi minimum, with 0.45 maximum water/cementitious materials ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- 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 using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

- D. Install 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, nonpressure, drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
  - 2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

### 3.2 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  - 3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
  - 4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
  - 5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

### 3.3 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

### 3.4 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3250 psi.

### 3.5 FIELD QUALITY CONTROL

- A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
  4. Submit separate report for each test.
  5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
    - a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
    - b. Close openings in system and fill with water.
    - c. Purge air and refill with water.
    - d. Disconnect water supply.
    - e. Test and inspect joints for leaks.
    - f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
  6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B. Leaks and loss in test pressure constitute defects that must be repaired.
- C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

## SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage pipe and drainage structures outside the building.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product installed.
- B. Field quality-control test reports.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

#### 2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

#### 2.3 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

#### 2.4 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  - 2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

## 2.5 CLEANOUTS

- A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.6 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  1. Diameter: 48 inches minimum, unless otherwise indicated.
  2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  4. Riser Sections: 4-inch minimum thickness, and of length to provide depth indicated.
  5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  6. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
  7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
  8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
  9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
  11. Manhole Frames and Covers: Ferrous; 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 cast into cover, using wording "STORM DRAIN."
    - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48, Class 35 gray iron, unless otherwise indicated.

## 2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, 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.

5. Ballast and Pipe Supports: Portland cement design mix, 3,000-psi minimum, with 0.58 maximum water-cementitious materials ratio.
  - a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - b. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

## 2.8 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
  3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (heavy traffic) structural loading unless otherwise indicated. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.
  1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.
    - b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

### 3.2 PIPING INSTALLATION

- A. 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 using lubricants, cements, and other installation requirements.
- B. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections unless direct tap into existing storm drain is indicated.
- C. Install 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.
- D. Install gravity-flow, nonpressure drainage piping according to the following:
  1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
  2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

- E. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
  - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  - 3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
  - 4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

### 3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

### 3.5 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

### 3.6 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3,250 psi.

### 3.7 FIELD QUALITY CONTROL

- A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.
  - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
  - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - 4. Submit separate report for each test.
  - 5. Hydrostatic Tests: Test sewers according to requirements of authorities having jurisdiction and the following:
    - a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
    - b. Close openings in system and fill with water.
    - c. Purge air and refill with water.



- d. Disconnect water supply.
- e. Test and inspect joints for leaks.
- 6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
- 7. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
  - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B. Leaks and loss in test pressure constitute defects that must be repaired.
- C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

## APPENDIX A: GEOTECHNICAL REPORTS



**REPORT OF GEOTECHNICAL ENGINEERING SERVICES**

Proposed Santa Monica Pico Branch Library

Virginia Avenue Park

Santa Monica, California

**Special Provisions Number 2119**



For  
City of Santa Monica  
October 8, 2010

GeoDesign Project: SMonica-10-01

October 8, 2010

City of Santa Monica  
Architecture Services  
1437 4<sup>th</sup> Street, Suite 300  
Santa Monica, CA 90401

Attention: Mr. Michael Collins, Architect

**Report of Geotechnical Engineering Services**

Proposed Santa Monica Pico Branch Library

Virginia Avenue Park

Santa Monica, California

**Special Provisions Number 2119**

GeoDesign Project: SMonica-10-01

GeoDesign, Inc. is pleased to submit this report of our geotechnical investigation for the for the proposed Santa Monica Pico Branch Library to be constructed within Virginia Avenue Park located at the northwest corner of Pico Boulevard and Cloverfield Boulevard in Santa Monica, California.

Our services were performed in general accordance with our proposal dated April 5, 2010, addendum dated April 16, 2010, and the terms and conditions of our contract for professional services with the City of Santa Monica dated May 26, 2010.

We appreciate the opportunity to be of service to you. Please contact us if you have questions regarding this report.

Sincerely,

GeoDesign, Inc.



Christopher J. Zadoorian, G.E.  
Principal Engineer

CJZ:SFK:kt

Attachments

Six copies submitted

Document ID: SMonica-10-01-100810-geor.doc

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**TABLE OF CONTENTS****PAGE NO.**

1.0	INTRODUCTION	1
2.0	PURPOSE AND SCOPE	1
3.0	SITE CONDITIONS AND GEOTECHNICAL EXPLORATIONS	2
3.1	Surface Conditions	2
3.2	Subsurface Conditions	2
3.3	Laboratory Testing	3
3.4	Infiltration Testing	3
4.0	GEOLOGIC CONCLUSIONS	4
4.1	General Conditions	4
4.2	Faults	4
4.3	Limited Geologic Hazard Evaluation	5
5.0	CONCLUSIONS	7
5.1	General	7
5.2	Foundations, Floor Slabs, and Pavement	7
5.3	On-Site Infiltration	7
6.0	RECOMMENDATIONS	7
6.1	Foundations	7
6.2	Floor Slabs	8
6.3	Pavement	9
6.4	Retaining Walls	10
6.5	Seismic Design	10
6.6	Site Preparation	13
6.7	Construction Considerations	14
6.8	Fill Materials	14
7.0	OBSERVATION OF CONSTRUCTION	15
8.0	LIMITATIONS	15

**FIGURES**

Vicinity Map	Figure 1
Site Plan	Figure 2
Geologic Map	Figure 3
Seismic Hazard Zone Map	Figure 4
Final Design Response Spectrum	Figure 5

## **TABLE OF CONTENTS**

## **PAGE NO.**

### **APPENDICES**

#### **Appendix A**

Field Exploration	A-1
Laboratory Testing	A-2
Exploration Key	Table A-1
Soil Classification System	Table A-2
Boring Logs	Figures A-1 - A-4
Moisture-Density Relationship	Figure A-5
Consolidation Test Results	Figure A-6
Direct Shear Test Results	Figure A-7
Summary of Laboratory Data	Figure A-8
AP Engineering & Testing, Inc. Expansion Index Test Results	
Schiff Associates Lab Test Results	
LaBelle-Marvin R-value Results	

#### **Appendix B**

Infiltration Testing	B-1
Infiltration Testing Calculations	

### **ACRONYMS**

## **1.0 INTRODUCTION**

This report presents the results of our geotechnical investigation for the proposed Santa Monica Pico Branch Library to be constructed within Virginia Avenue Park located at the northwest corner of Pico Boulevard and Cloverfield Boulevard in Santa Monica, California.

The proposed project consists of constructing a one-story, approximately 7,500-square-foot branch library building at grade and adjacent surface parking to accommodate 30 vehicles. The site location is shown on Figure 1. For your reference, definitions of all acronyms used in this report are attached at the end of this document.

At the time this report was prepared, the precise footprint of the library building had not been selected; however, it has been determined that the proposed building will be located within an L-shaped area south of the Thelma Terry Community Center that is the current site of the Farmer's Market.

The proposed parking area will be constructed on the east side of the park, approximately 200 feet to the east of the library building, adjacent to Cloverfield Boulevard. This proposed parking area is currently landscaped with various plants, trees, and a lawn area traversed by a meandering concrete walkway.

You provided us with survey dated August 4, 2010 prepared by JMC<sup>2</sup> for the proposed project. Based on our review of the site topography and understanding of the proposed development, graded slopes or excavations for basement walls or large grade changes are not planned. Although, minor retaining walls may be required depending on the location of the proposed building.

The project will utilize on-site infiltration of surface water as a means to limit discharge of surface water to the storm drain system.

## **2.0 PURPOSE AND SCOPE**

The purpose of our services was to provide geotechnical engineering recommendations for design and construction of the proposed library and surface parking lot. All services will be performed in accordance with the CBC and the Santa Monica Municipal Code. We completed the following scope of services:

- Coordinated and managed the field investigation, including utility checks, permit applications, site access authorization, and scheduling of subcontractor and GeoDesign field staff.
- Drilled four borings to depths ranging from 10.5 to 36.5 feet BGS using hollow-stem auger drilling equipment.
- Obtained relatively undisturbed and bulk samples from the borings for laboratory testing and maintained a log of the soil conditions encountered in each boring.
- Performed infiltration testing in two borings, one at the site of the proposed library and one at the site of the proposed parking lot.

- Performed a geologic-seismic hazards evaluation.
- Performed geotechnical laboratory testing on selected samples from the borings.
- Performed corrosion testing and "R" value testing on selected samples.
- Evaluated the liquefaction potential of the soils at the site.
- Provided recommendations for allowable and ultimate bearing capacity for spread footings.
- Provided recommendations for passive and frictional resistance of the foundation soils to resist lateral loading.
- Provided recommendations for retaining wall foundations, wall design, drainage, and backfill.
- Provided recommendations for building and floor slab design.
- Provided site-specific seismic design criteria in accordance with the 2007 CBC.
- Provided recommendations for pavement design.
- Provided recommendations for grading.
- Prepared this report summarizing the results of our geotechnical evaluation.

### **3.0 SITE CONDITIONS AND GEOTECHNICAL EXPLORATIONS**

#### **3.1 SURFACE CONDITIONS**

The proposed library building will be constructed within an existing paved patio area south of the Thelma Terry Community Center. This area is currently used as the site of the Farmer's Market. The patio area is landscaped with a grove of trees with raised concrete planters on the north, south, and west with minor planters on the east and south. The ground surface slopes gently to the south and ranges from approximately Elevation 166 to Elevation 159.

The proposed parking lot will be constructed east of the proposed library building site adjacent to Cloverfield Boulevard. The ground surface in this area slopes gently to the southwest and ranges approximately from Elevation 167 to Elevation 165 feet.

Figure 2 shows the park and locations of the proposed library building and parking lot.

#### **3.2 SUBSURFACE CONDITIONS**

We explored the site by drilling four borings (B-1 through B-4) at the locations shown on Figure 2 using limited-access, hollow-stem auger drilling equipment. The borings were drilled to depths ranging from 10.5 to 36.5 feet BGS at the locations shown Figure 2.

Borings B-1, B-2, and B-3 were drilled within the area of the proposed library building. Boring B-4 was drilled within the proposed parking lot. Infiltration tests were performed in borings B-2 and B-4, one test in each of the proposed building areas.

Fill soils were encountered in borings B-1, B-3 and B-4 and ranged in thickness from 1 to 2 feet consisting of medium dense, fine sand with silt and silty sand. The native soils underlying the fill and encountered at the surface in boring B-2 consist of predominantly medium dense, fine sand with silt to depths of 14 to 14.5 feet BGS. Below this depth, the native soils consist of medium dense, fine to medium sand. The soils become dense at a depth of approximately 10 feet BGS.

Concrete was encountered at the ground surface in borings B-1 and B-3, ranging in thickness of 3 to 4 inches. Base materials were not observed below the concrete.



Groundwater was not encountered in the borings to the depths explored. The current groundwater level in the general site vicinity is greater than 60 feet BGS and should not adversely impact the proposed development. The historical high groundwater level is at a depth of approximately 40 feet BGS or greater (CGS, 1998).

The logs of our borings are presented in Appendix A of this report.

### 3.3 LABORATORY TESTING

Selected samples collected from our borings were tested for the following:

- In-place moisture and density
- Direct shear
- Consolidation
- Expansion (performed by AP Engineering & Testing, Inc.)
- Corrosion potential (testing performed by Schiff Associates)
- R-Value (performed by LaBelle Marvin)

Descriptions of the testing and the test results from the current investigation are presented in Appendix A.

### 3.4 INFILTRATION TESTING

Infiltration testing was performed in borings B-2 and B-4 to provide an estimated infiltration rate to be used in design of on-site infiltration systems. The test utilized the falling-head test method that includes filling the PVC casing with water and recording the water level drop over regular time intervals. The testing methodology is described in more detail in Appendix B of this report.

Table 1 summarizes the results of our infiltration tests; supporting calculations are presented in Appendix B.

**Table 1. Summary of Infiltration Test Results**

Test Location	Test Depth (feet BGS)	Soil Type	Minutes per Inch		Inches per Hour	
			Average	Lowest Value	Average	Lowest Value
B-2	0 – 9.4	SP-SM Sand with Silt	57.48	60.00	1.04	1.00
B-4	0 – 10.0	SP-SM/SP Sand with Silt/Fine Sand	49.06	53.77	1.22	1.12

Based on the site conditions and the results of our infiltration tests, on-site disposal of surface runoff collected at the site is feasible. However, if utilized, the specific locations of on-site infiltration should be carefully planned and kept a sufficient distance away from building foundations as discussed in the “Foundations, Floor Slabs and Pavement” section of this report.

An infiltration rate between the average and the most conservative rate is typically selected for use when designing drywell systems, retention basins, or sewage disposal systems. In this case, the average infiltration rate is 1.04 to 1.22 inches per hour for borings B-2 and B-4, respectively, and the most conservative value is 1.00 to 1.12 inches per hour for borings B-2 and B-4, respectively.

It should be noted that the infiltration rates calculated during our field investigation are based on rates determined during short duration field tests and could vary from actual long-term rates. Also, the infiltration tests were clear-water tests, and infiltration rates would be affected by silt buildup, debris, or other factors that occur at the site in the future.

## **4.0 GEOLOGIC CONDITIONS**

### **4.1 GENERAL CONDITIONS**

The site is located on the Ocean Park Plain, an older Pleistocene age, slightly dissected alluvial surface along the northern boundary of Ballona Gap. The sediments underlying the Ocean Park Plain consist of Pleistocene age alluvium that generally consists of stratified sands with some beds of silt, silty sand, and fine gravel.

The active Santa Monica Fault traverses the Santa Monica Plain to the north. In the Santa Monica area, the Santa Monica Fault is mapped as two distinct traces, the South Branch and the North Branch.

The geologic conditions at the site and in the site vicinity are shown on Figure 3.

### **4.2 FAULTS**

#### **4.2.1 General**

Faults in Southern California are considered active, potentially active, and inactive based on criteria developed by CGS for the Alquist-Priolo Earthquake Fault Zoning Program (Hart, 1999). By definition, an active fault is one that has had surface displacement within Holocene time (approximately the last 11,000 years). A potentially active fault is one that has demonstrated surface displacement of Quaternary age deposits (last 1.6 million years). Inactive faults have not moved in the last 1.6 million years.

The primary purpose of the Alquist-Priolo Earthquake Fault Zoning Program is to identify sites that have a potential for surface rupture due to active faults that are in close proximity. In such cases, a building setback zone is established to mitigate the potential for surface rupture.

#### **4.2.2 Santa Monica Fault Zone**

The South Branch of the Santa Monica Fault is the closest active fault to the site, located approximately 0.5 mile to the north (City of Santa Monica, 2001; Dolan et al., 2000; Ziony and Jones, 1989). The Santa Monica Fault is the western segment of the Santa Monica-Hollywood Fault Zone, which trends east-west from the Santa Monica coastline on the west to the Hollywood area on the east. In the Santa Monica area, the Santa Monica Fault splays into two segments: the North Branch and the South Branch (City of Santa Monica, 2001).

Studies have indicated that the fault is active based on geomorphic evidence and fault trenching studies (Dolan, et al., 2000; Dolan and Sieh, 1992; and Crook and Proctor, 1992). The Santa Monica Fault has not yet been zoned as active under the Alquist-Priolo Earthquake Fault Zoning Act. However, the City of Santa Monica considers the fault active for planning purposes.

#### **4.2.3 Blind Thrust Faults**

Several deep thrust faults, commonly referred to as blind thrusts, underlie the greater Los Angeles area. These faults are not exposed at the ground surface and are typically identified at depths greater than 3 kilometers. These faults do not present a potential surface fault rupture hazard but are considered active and potential sources for future earthquakes. The closest of these blind thrusts to the site is the Northridge Thrust, located approximately 6.5 miles to the north. The Northridge Thrust underlies the majority of the San Fernando Valley and is believed to be the causative fault for the 1994 Magnitude 6.7 Northridge Earthquake.

### **4.3 LIMITED GEOLOGIC HAZARD EVALUATION**

Our limited geologic seismic hazards evaluation included a review of published and unpublished geologic maps, reports, and documents, including the City of Santa Monica public safety documents and the State of California Alquist-Priolo Earthquake Fault Zone maps and Seismic Hazard Zone maps. The results of our evaluation are presented below.

#### **4.3.1 Fault Rupture**

The site is not within a currently established State of California Alquist-Priolo Earthquake Fault Zone or a City of Santa Monica Hazard Management Zone for surface fault rupture hazards. Although the Santa Monica Fault is located within a mile of the site, CGS has not established an Alquist-Priolo Earthquake Fault Zone for the Santa Monica Fault due to its lack of surface definition in the urbanized Santa Monica-West Los Angeles area.

The closest Alquist-Priolo Earthquake Fault zone is located approximately 4.9 miles east of the site, established for the active Newport-Inglewood Fault Zone. Based on the available geologic data, active or potentially active faults with the potential for surface fault rupture are not known to be located directly beneath or projecting toward the site. Therefore, the potential for surface rupture due to fault plane displacement propagating to the surface at the site during the design life of the project is considered low.

#### **4.3.2 Seismicity**

The site is located in a seismically active area and could be subjected to strong ground shaking in the event of an earthquake. However, this hazard is common in Southern California, and the effects of strong ground shaking can be mitigated by proper engineering design and construction in conformance with current building codes and engineering practices.

#### **4.3.3 Liquefaction**

Liquefaction generally occurs in saturated, loose to medium dense, granular soils and in saturated, soft to moderately firm silts as a result of strong ground shaking. As the density and/or particle size of the soil increases and as the confinement (overburden pressure) increases, the potential for liquefaction decreases.

The site is not located within an area identified as having a potential for liquefaction by the Seismic Hazard Zone maps published by the CGS (CDMG, 1999) and is not located in an area of "Liquefaction Risk" identified in the City of Santa Monica's safety documents (City of Santa Monica, 2001). The historical high groundwater level in the site vicinity is at a depth greater than 40 feet BGS (CDMG, 1998), and groundwater is at a depth greater than 60 feet in the area (based on information reviewed on the State of California Geotracker website).

Considering the dense nature of the Pleistocene age deposits at the site and the depth to groundwater, the potential for soil liquefaction at the site is considered to be very low.

The site location relative to liquefaction hazard zones identified by the CGS (1999) is shown on Figure 4.

#### **4.3.4 Slope Stability**

The site is relatively level and is not considered to have a potential for slope instability. Site elevations in the area of the proposed library are gently sloping to the south and range from approximately Elevation 159 to Elevation 166 over a distance of approximately 220 feet. Elevations in the area of the proposed parking lot range from approximately Elevation 165 to Elevation 167.

The site is located approximately 1.6 miles from the ocean and is not located in the area that could be affected by instability of the coastal bluffs. The topography of the site is relatively level to gently sloping and the site is not located in an area identified in the City of Santa Monica's safety documents as having a "Landslide Susceptibility Risk." There are no known landslides near the site nor is the site in the path of any known or potential landslides. In addition, CGS does not identify the site within an area identified as having a potential for seismic slope instability (CDMG, 1999). Therefore, the site is considered grossly stable and not subject to slope stability hazards.

#### **4.3.5 Tsunamis, Inundation, and Flooding**

The site is located approximately 1.6 miles from the coastline at elevations ranging from approximately Elevation 159 to Elevation 167. Although located in a coastal area, the elevated nature of the site precludes tsunami hazards.

The site is not within a 100-year flood zone (FEMA, 2008) or a potential inundation area for an earthquake-induced dam failure (County of Los Angeles, 1990). Therefore, the potential for flooding at the site is considered low.

#### **4.3.6 Clay Pits**

The site is not located in an area identified in the City of Santa Monica's safety documents as being located in an area of a former clay pit or landfill.

## **5.0 CONCLUSIONS**

### **5.1 GENERAL**

The proposed development is feasible from a geotechnical perspective and will not adversely impact adjacent sites. The site is generally free from geologic and seismic hazards.

The expansion index test results indicate the soils are classified as having a very low potential for expansion.

Corrosion test results indicate the soils at the site are not aggressive to concrete.

### **5.2 FOUNDATIONS, FLOOR SLABS, AND PAVEMENT**

The current proposed development includes at-grade structures, and the planned foundation level in each case would be on the order of 3 feet BGS. Medium dense to dense, sandy soils are present at these depths within the proposed building area.

Consolidation testing performed on the upper native soils did not indicate sensitivity to changes in moisture content. Therefore, the proposed building foundations may be established in the medium dense to dense, native, sandy soils at the site.

Floor slabs, flatwork, and pavement may also be supported on the medium dense to dense, native soils or properly compacted fill materials as discussed in the "Floor Slabs" and "Pavement" sections of this report.

### **5.3 ON-SITE INFILTRATION**

Based on the site conditions and the results of our infiltration tests, on-site disposal of surface runoff collected at the site is feasible. However, if utilized, the specific locations of on-site infiltration should be carefully planned and kept a sufficient distance away from building foundations as discussed in the "Foundations" section of this report.

## **6.0 RECOMMENDATIONS**

### **6.1 FOUNDATIONS**

#### **6.1.1 Allowable Bearing Pressure**

The proposed building may be supported on spread footings established in the medium dense to dense, native soils. Spread footings established at least 2 feet below the lowest adjacent grade or top of floor slab can be designed for an allowable bearing pressure of 3,500 psf.

The recommended bearing pressure is a net value and applies to the total of dead and long-term live loads and may be increased up to one-third when considering earthquake or wind loads. The weight of the footing and overlying backfill can be neglected when calculating footing loads.

#### **6.1.2 Settlement**

We estimate the total settlement for the proposed structures to be on the order of ½ inch or less and the differential settlement to be on the order of ¼ inch or less.

In combination with the potential for seismically induced settlement, the total settlement that may occur is estimated to be 1 inch or less.

### **6.1.3 Lateral Resistance**

Lateral loading may be resisted using a passive pressure of 400 psf per foot of depth or footings where the concrete is placed directly against the native soils.

A coefficient of friction equal to 0.4 may be used when calculating resistance to sliding for foundations bearing on native soils.

The passive resistance and the frictional resistance may be used in combination without reduction and may also be increased by one-third when considering short-term seismic and wind loading.

### **6.1.4 Considerations for Site Infiltration**

Infiltration is feasible at the site; however, we recommend that infiltration wells or linear features be located at least 50 feet from the proposed library building.

## **6.2 FLOOR SLABS**

The precise location of the library building has not been established yet, nor has the plan finish floor level. Depending on the location of the building within the current designated area, minor cuts and fills will likely be required to establish the plan finish floor level.

The soils present for floor slab support will consist of the following:

- Existing undocumented fill
- Materials that are disturbed as a result of the demolition process
- Medium dense, native soils

To provide uniform support for floor slabs, all existing fill soils and soils disturbed as a result of the required demolition should be removed and recompact as recommended in the "Construction Considerations" section of this report. Existing native soils that are not disturbed may remain in place.

Satisfactory subgrade support for floor slabs supporting up to an estimated 500 psf areal loading on the properly compacted fill can be obtained provided the building areas are prepared as recommended.

We recommend that a capillary break section be installed beneath building floor slabs. The capillary break should consist of 4 inches of  $\frac{3}{4}$ -inch-minus gravel overlain by 2 inches of clean sand. A 10-mil moisture barrier should be installed on the 2-inch sand layer and the barrier should then be covered with 2 more inches of sand for protection.

## 6.3 PAVEMENT

### 6.3.1 AC Pavement

To provide uniform support for AC pavement, the upper 18 inches of soil should be removed and recompacted as recommended in "Construction Considerations" section of this report.

Testing performed on a bulk sample of the upper soils indicated an R-value of 69. Traffic loading and traffic indices were not provided; however, general information regarding the anticipated traffic loading was provided. Based on our understanding of the traffic loading, we have assumed traffic index values for primary traffic loading as outlined in Table 2.

**Table 2. Asphalt Pavement Design Sections**

Traffic Use	Traffic Index	AC (inches)	Base Course (inches)
Parking Areas	5	3	4
Drive and Loading Dock Access Lanes	7	4	4

The asphalt paving sections were determined using the California Department of Transportation design method. We can determine the recommended paving and base course thickness for other traffic indices if required. Careful inspection is recommended to confirm that the recommended thickness or greater are achieved and that proper construction procedures are followed.

The base course should conform to requirements of Section 26 of State of California Department of Transportation Standard Specifications for Public Works Construction (Green Book). The base course should be compacted to at least 95 percent.

### 6.3.2 PCC Pavement

To provide uniform support for PCC pavement, the upper 18 inches of soil should be removed and recompacted as recommended in "Construction Considerations" section of this report.

For the design of PCC pavement, we have assumed that the concrete will have a minimum compressive strength 3,000 psi. The required paving and base thickness will depend on the expected wheel loads and volume of traffic (traffic index). Assuming that the paving subgrade will consist of the on-site or comparable soils compacted to at least 95 percent as recommended, the minimum recommended paving thickness are presented in the Table 3.

**Table 3. PCC Pavement Design Sections**

Traffic Use	Traffic Index	PCC (inches)	Base Course (inches)
Parking Areas	5	5	4
Drive and Loading Dock Access Lanes	7	6	4

We recommend that the concrete pavement be properly reinforced. In addition, dowels are recommended at joints to reduce any possible offsets. Careful inspection is recommended to

check that the recommended thickness or greater are achieved and that proper construction procedures are followed. As mentioned previously, the transition zone will be critical to the performance of concrete pavement.

The base course should conform to requirements of Section 26 of State of California Department of Transportation Standard Specifications, latest edition, or meet the specifications for untreated base as defined in Section 200-2 of the latest edition of the Standard Specifications for Public Works Construction (Green Book). The base course should be compacted to at least 95 percent.

#### **6.4 RETAINING WALLS**

We anticipate that minor retaining walls on the order of 3 feet maximum retained height may be required. For structural evaluation of retaining walls, we recommend that the wall be designed to resist a triangular-shaped lateral earth pressure distribution with the maximum value equal to  $30H$  psf, where  $H$  is the height of the wall.

Lateral loading on walls may be resisted using the passive resistance between the soils and the bottom of the footing. A passive pressure of 300 psf per foot of embedment may be used in conjunction with a coefficient of friction of 0.4.

#### **6.5 SEISMIC DESIGN**

The procedure outlined in ASCE-7 is based on the MCE, which is defined as an earthquake that results in ground motions that have a 2 percent chance of being exceeded in 50 years (a 2,475-year recurrence interval). This procedure is outlined in Table 4.

**Table 4. Summary of ASCE-7 Procedure for Seismic Design**

<b>Step</b>	<b>Procedure</b>	<b>Reference</b>
1	Compute Generalized Response Spectrum	ASCE 11.4.5
2	Compute MCE Response Spectrum	ASCE 11.4.6
3	Compute Probabilistic MCE Response Spectrum	ASCE 21.2.1
4	Compute Median Deterministic Response Spectrum	ASCE 21.2.2
5	Compute Deterministic MCE Response Spectrum	ASCE 21.2.2
6	Compute Deterministic Lower Limit on MCE Response Spectrum	ASCE 21.2.2
7	Compute Final Deterministic MCE Response Spectrum	ASCE 21.2.2
8	Compute Site-Specific MCE Response Spectrum	ASCE 21.2.3
9	Compute Two-Thirds of Design MCE Response Spectrum	ASCE 21.3
10	Compute 80 Percent of Generalized Design Response Spectrum	ASCE 21.3
11	Compute Final Design Response Spectrum	ASCE 21.3
12	Compute Final Design Acceleration Parameters	ASCE 21.4

The following sections outline our analysis methodology and present the results of our study.



### **STEP 1 - GENERALIZED RESPONSE SPECTRUM**

The generalized response spectrum for a site is developed by identifying the spectral ordinates at periods of 0.2 and 1 second and identifying the appropriate site class in accordance with Table 1613.5.2 of the 2006 IBC. The spectral ordinates are obtained based on the site location from maps presented in Section 1613 of the 2006 IBC, or if the site class is  $S_p$ , then based on a site-specific analysis.

In accordance with the data obtained from our field investigation, the soils at the site may be classified as Site Type  $S_D$ . This classification is based on the blow count data from our explorations at the site.

Section 11.4.5 of ASCE-7 summarizes the development of the generalized design response spectrum and the results of our analysis are for the site is presented in Table 5.

### **STEP 2 - MCE RESPONSE SPECTRUM**

The MCE response spectrum is simply defined as the generalized response spectrum multiplied by 1.5. The MCE response spectral ordinates are presented in Table 5.

### **STEP 3 - PROBABILISTIC MCE RESPONSE SPECTRUM**

The probabilistic MCE response spectrum is developed by performing a PSHA that takes into account faults that are a potential source of strong ground shaking at the site based on a given risk, defined as the recurrence interval. For the MCE, the recurrence interval is 2,475 years, which corresponds to ground motions that have a 2 percent probability of being exceeded in 50 years, as stated in Section 21.2.1 of ASCE-7.

Up until recently, the general practice in California to perform a PSHA has included the use of four ground motion attenuation relationships published in 2007 and 2008, collectively referred to as the NGA relationships, which are summarized below:

- Campbell-Bozorgnia (2008)
- Chiou-Youngs (2008)
- Boore-Atkinson (2008)
- Abruhamson-Silva (2008)

Based on the data collected from our borings and the prior data available, we assumed a shear wave velocity of 900 feet per second to represent the soils at the site for use in our analysis.

The resulting probabilistic MCE response spectrum is presented in Table 5.

### **STEP 4 - MEDIAN DETERMINISTIC RESPONSE SPECTRUM**

The deterministic MCE response spectrum is also developed by using EZ Frisk in conjunction with the attenuation relationship and soil stiffness estimate discussed above. The deterministic approach simply considers the maximum ground acceleration that may occur at the site as a result of an earthquake. The deterministic analysis differs from the probabilistic analysis in that recurrence intervals are not considered.

The resulting median deterministic response spectrum is presented in Table 5.

***STEP 5 - DETERMINISTIC MCE RESPONSE SPECTRUM***

The deterministic MCE response spectrum is computed by taking 150 percent of the median deterministic response spectrum and is presented in Table 5.

***STEP 6 - DETERMINISTIC LOWER LIMIT ON MCE RESPONSE SPECTRUM***

The deterministic lower limit MCE response spectrum is defined in ASCE-7 Section 21.2.2 as the response spectrum that results using prescribed spectral ordinates of 1.5 and 0.6 for 0.2 and 1 second periods, respectively. The resulting deterministic lower limit on MCE response spectrum is presented in Table 5.

***STEP 7 - FINAL DETERMINISTIC MCE RESPONSE SPECTRUM***

The final deterministic MCE response spectrum is the greater of the deterministic MCE and the lower limit response spectrum as defined in ASCE-7 Section 21.2.2 and is presented in Table 5.

***STEP 8 - SITE-SPECIFIC MCE RESPONSE SPECTRUM***

As outlined in ASCE-7 Section 21.2.3, the site-specific MCE response spectrum shall be taken as the lesser of the probabilistic MCE computed in Step 3 and the final deterministic MCE computed in Step 7. The resulting site-specific MCE response spectrum is presented in Table 5.

***STEP 9 - TWO-THIRDS OF THE SITE-SPECIFIC DESIGN RESPONSE SPECTRUM***

Section 21.3 of ASCE-7 allows the site-specific MCE response spectrum computed in Step 8 to be factored by two-thirds for subsequent comparison to 80 percent of the generalized response spectrum that was computed in Step 1. Two-thirds of the site-specific MCE response spectrum is presented in Table 5.

***STEP 10 - 80 PERCENT OF THE GENERALIZED RESPONSE SPECTRUM***

Section 21.3 of ASCE-7 establishes the lower bound for design ground motions as 80 percent of the generalized response spectrum computed in Step 1. Eighty percent of the generalized response spectrum is presented in Table 5.

***STEP 11 - FINAL DESIGN RESPONSE SPECTRUM***

To develop the final design response spectrum in Step 8, the spectral ordinates computed in Steps 9 and 10 are compared. If the values computed in Step 9 are less than 80 percent of the generalized response spectrum, the value from the 80 percent response spectrum is used; otherwise, the values computed in Step 9 are used.

The resulting final design response spectrum is, therefore, a hybrid curve based on the generalized response spectrum, the probabilistic MCE response spectrum, and the deterministic MCE response spectrum. The final design response spectrum is presented in Table 5.

Table 5. Spectral Ordinates

Period (s)	Computed Spectral Ordinate from Steps 1 through 11 (g)										
	Step Number										
	1	2	3	4	5	6	7	8	9	10	11
0.000	0.449	0.674	0.732	0.537	0.805	1.500	1.500	0.732	0.488	0.359	0.488
0.050	0.765	1.147	0.894	0.615	0.923	1.500	1.500	0.894	0.596	0.612	0.612
0.100	1.080	1.620	1.217	0.783	1.175	1.500	1.500	1.217	0.812	0.864	0.864
0.200	1.123	1.685	1.515	1.009	1.513	1.500	1.513	1.513	1.009	0.899	1.009
0.300	1.123	1.685	1.538	1.092	1.638	1.500	1.638	1.538	1.026	0.899	1.026
0.400	1.123	1.685	1.467	1.073	1.609	1.500	1.609	1.467	0.978	0.899	0.978
0.500	1.123	1.685	1.386	1.018	1.527	1.500	1.527	1.386	0.924	0.899	0.924
0.750	0.800	1.200	1.175	0.865	1.298	1.200	1.298	1.175	0.784	0.640	0.784
1.000	0.600	0.900	0.983	0.702	1.053	0.900	1.053	0.983	0.655	0.480	0.655
2.000	0.300	0.450	0.543	0.376	0.564	0.450	0.564	0.543	0.362	0.240	0.362
3.000	0.200	0.300	0.350	0.237	0.356	0.300	0.356	0.350	0.234	0.160	0.234
4.000	0.150	0.225	0.252	0.168	0.252	0.225	0.252	0.252	0.168	0.120	0.168

#### STEP 12 - COMPUTATION OF FINAL ACCELERATION PARAMETERS

Computation of the final acceleration parameters requires comparing the values computed for  $S_{DS}$ ,  $S_{D1}$ ,  $S_{MS}$ , and  $S_{M1}$  with limiting values in accordance with ACSE-7 Section 21.4. Table 6 summarizes the parameters used in Step 1 and presents the final acceleration parameters in accordance with ASCE-7, Section 21.4.

Table 6. Final Acceleration Parameters

Parameter	Short Period ( $T_s = 0.2$ second)	1-Second Period ( $T_1 = 1.0$ second)
MCE Spectral Acceleration, $S$	1.17	0.415
Site Class	D	
Site Coefficient, $F_a$ and $F_v$	1.00	1.5
Adjusted Spectral Acceleration, $S_M$	$S_{MS} = 1.514$ g	$S_{M1} = 0.983$ g
Design Spectral Response Acceleration Parameters, $S_D$	$S_{DS} = 1.009$ g	$S_{D1} = 0.724$ g

#### 6.6 SITE PREPARATION

Site preparation includes tasks to be performed prior to placement of new fill material to achieve the planned site grades. For the proposed development, the geotechnical site work will include removal and re-compaction of near-surface soils as previously recommended in this report.

The removal and re-compaction should extend at least 18 inches below the bottom of pavement and other flatwork sections. All areas to receive new fill should be scarified to a depth of 6 inches and compacted in accordance with the requirements outlined in the "Compaction" section of this report.

Earthwork should be planned and executed to minimize subgrade disturbance. Soil that has been disturbed during site preparation or soft or loose zones that are identified during probing should be removed from beneath proposed foundations or slabs on grade.

Our representative should observe the removal, replacement, and compaction work and perform field density testing to confirm the required degree of compaction was obtained.

## **6.7 CONSTRUCTION CONSIDERATIONS**

### **6.7.1 General**

If not carefully executed, site preparation and footing excavation can result in the presence of unsuitable (disturbed and/or excessively soft) soil conditions that may require additional effort to mitigate or, in more extreme cases (if not detected), could result in significant costs to repair damage to flatwork or structures.

### **6.7.2 Compaction**

All granular fill materials should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557. Cohesive fill materials should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D 1557. Field density testing should be performed by our representative to confirm the compaction of the fill soils. Fill materials should be placed in loose lifts not exceeding 8 inches in thickness, properly moisture conditioned, and mechanically compacted to the minimum required density. For granular fills, compaction may be achieved using heavy equipment and vibration.

### **6.7.3 Site Drainage**

Adequate site drainage should be maintained at all times. Site drainage should be collected and routed to suitable discharge points.

## **6.8 FILL MATERIALS**

Fill materials should be free of organic matter and other deleterious materials and, in general, should consist of particles no larger than 3 inches in largest dimension. Existing asphalt pavement and base materials generated from on-site demolition can be used for structural fill, although the percentage of such materials should be limited to less than 5 percent of the fill content. The on-site native, granular soils are suitable for use in the required fills provided that particles larger than 3 inches in largest dimension are removed. The following sections provide recommendations for the re-use of on-site materials in compacted fills and for the use of imported materials in required fills.

### **6.8.1 On-Site Native Soils**

The on-site native soils are suitable for use in the required fills provided that particles larger than 3 inches in largest dimension are removed.

### **6.8.2 Imported Granular Material**

If necessary, imported granular material should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand that is well graded and has less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve. The percentage of fines can be increased to 12 percent if the fill is placed during dry weather and provided the fill material is properly moisture conditioned to achieve the required compaction. Imported fill materials should have a sand equivalent of at least 35 percent.

## **7.0 OBSERVATION OF CONSTRUCTION**

Geotechnical testing and observation during construction is considered to be a continuing part of the geotechnical consultation. In order to confirm that the recommendations presented herein remain applicable, our representative should be present at the site to provide appropriate observation and testing. As satisfactory earthwork and the foundation performance depend to a large degree on the quality of construction, it is essential that qualified personnel be present to perform the required geotechnical testing and inspection.

The presence of an experienced representative at the site during construction provides value and benefits to the project and can often result in schedule and cost savings for the owner by approaching the geotechnical testing and inspection responsibilities in a proactive and team-oriented manner.

## **8.0 LIMITATIONS**

We have prepared this revised report for use by the City of Santa Monica and members of their design and construction team for the proposed development. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions and are not applicable to other sites.

Soil explorations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

The conclusions and recommendations presented in this report are based on the current site development plan and structural information provided to us by the project team. If design changes are made, we should be retained to review our conclusions and recommendations and to provide a written evaluation or modification.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our revised report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with that degree of skill and care ordinarily exercised by reputable geotechnical consultants practicing in this area at the time this revised report was prepared. No warranty or other conditions, expressed or implied, should be understood.

♦ ♦ ♦

We appreciate the opportunity to be of service to you. Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

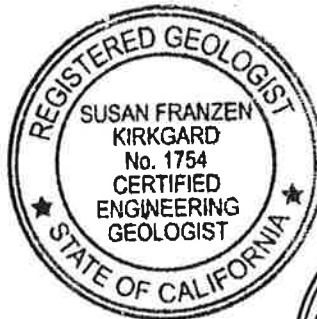
GeoDesign, Inc.



Susan F. Kirkgard, C.E.G.  
Associate Engineering Geologist



Christopher J. Zadoorian, G.E.  
Principal Engineer



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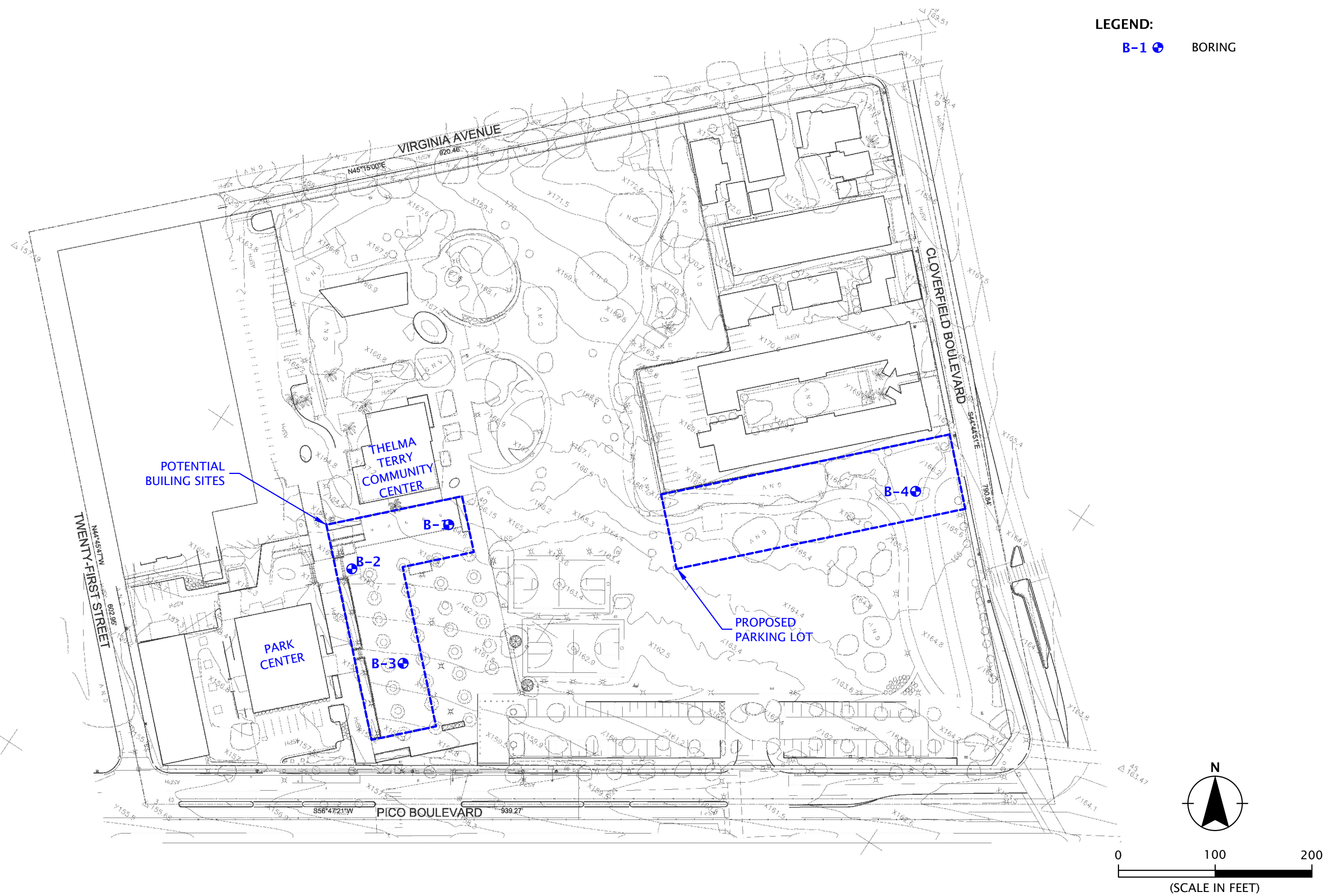
## FIGURES





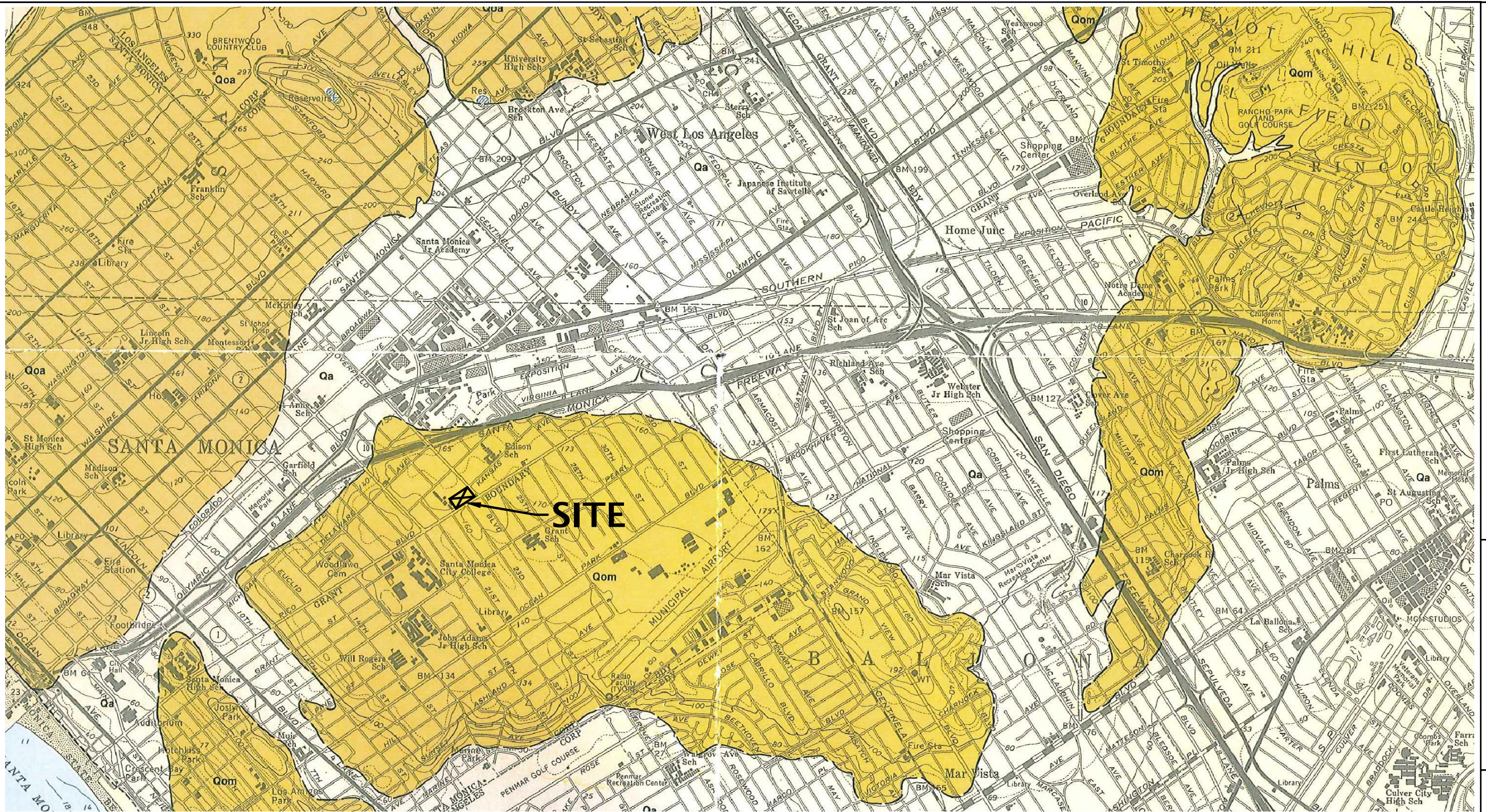


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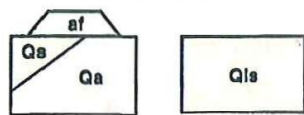


SITE PLAN BASED ON DRAWING PROVIDED BY  
MICHAEL COLLINS, ARCHITECT, CITY OF SANTA MONICA  
SEPTEMBER 7, 2010





BEVERLY HILLS—VAN NUYS (South 1/2)  
QUADRANGLES  
LEGEND



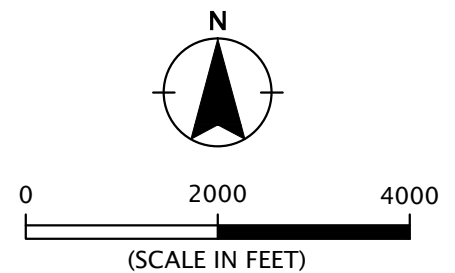
**SURFICIAL SEDIMENTS**  
unconsolidated detrital sediments; generally undissected  
af artificial cut and fill Qls landslide debris  
Qs beach sand  
Qa alluvial gravel, sand, and silt-clay, derived mostly from Santa Monica Mountains; includes gravel and sand of stream channels

—UNCONFORMITY—  
in mountain areas

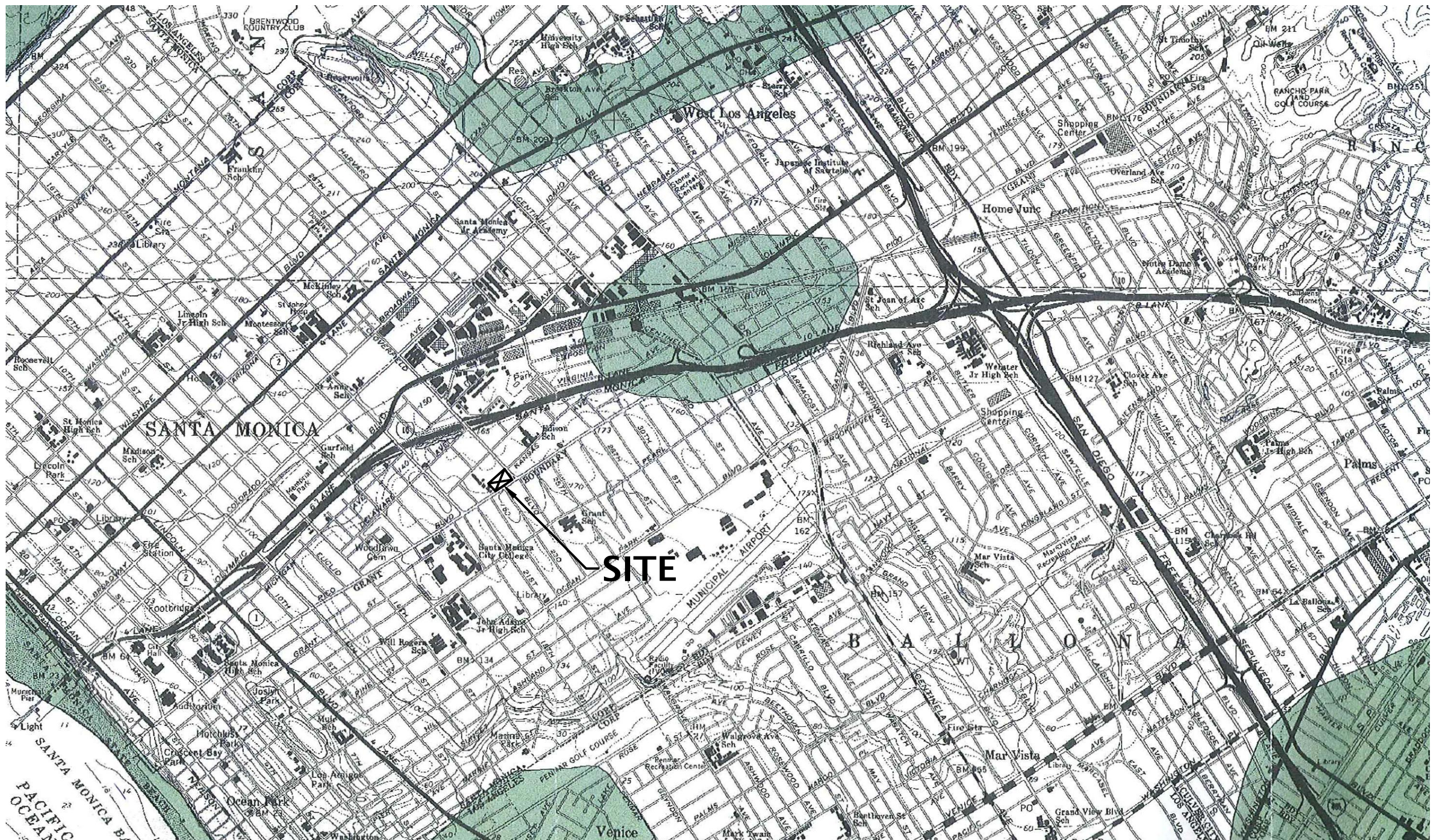


**SHALLOW MARINE SEDIMENTS**  
shallow marine and some alluvial detrital sediments,  
weakly consolidated, dissected where elevated; Pleistocene age  
Qom marine deposits of Hoots 1931: light gray to light brown sand, pebbly sand gravel and silt;  
probably in part non-marine alluvium  
Qsp San Pedro Sand (of Wright 1987; Culver Sand of Weber et al. 1982, in Baldwin Hills): light  
gray to light brown sand, fine to coarse grained or pebbly, locally contains shell fragments  
Ql Inglewood Formation (of Wright 1987; Weber et al. 1982, in Baldwin Hills): light gray, friable fine  
grained sandstone and interbedded soft gray siltstone; base not exposed

REFERENCE: DIBBLEE, T.W., JR., 1991, "GEOLOGIC MAP OF  
THE BEVERLY HILLS AND VAN NUYS (SOUTH 1/2)  
QUADRANGLES LOS ANGELES COUNTY, CA."  
DIBBLEE GEOLOGIC FOUNDATION MAP #DF-31.





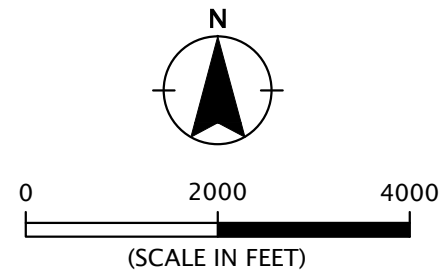


#### MAP EXPLANATION

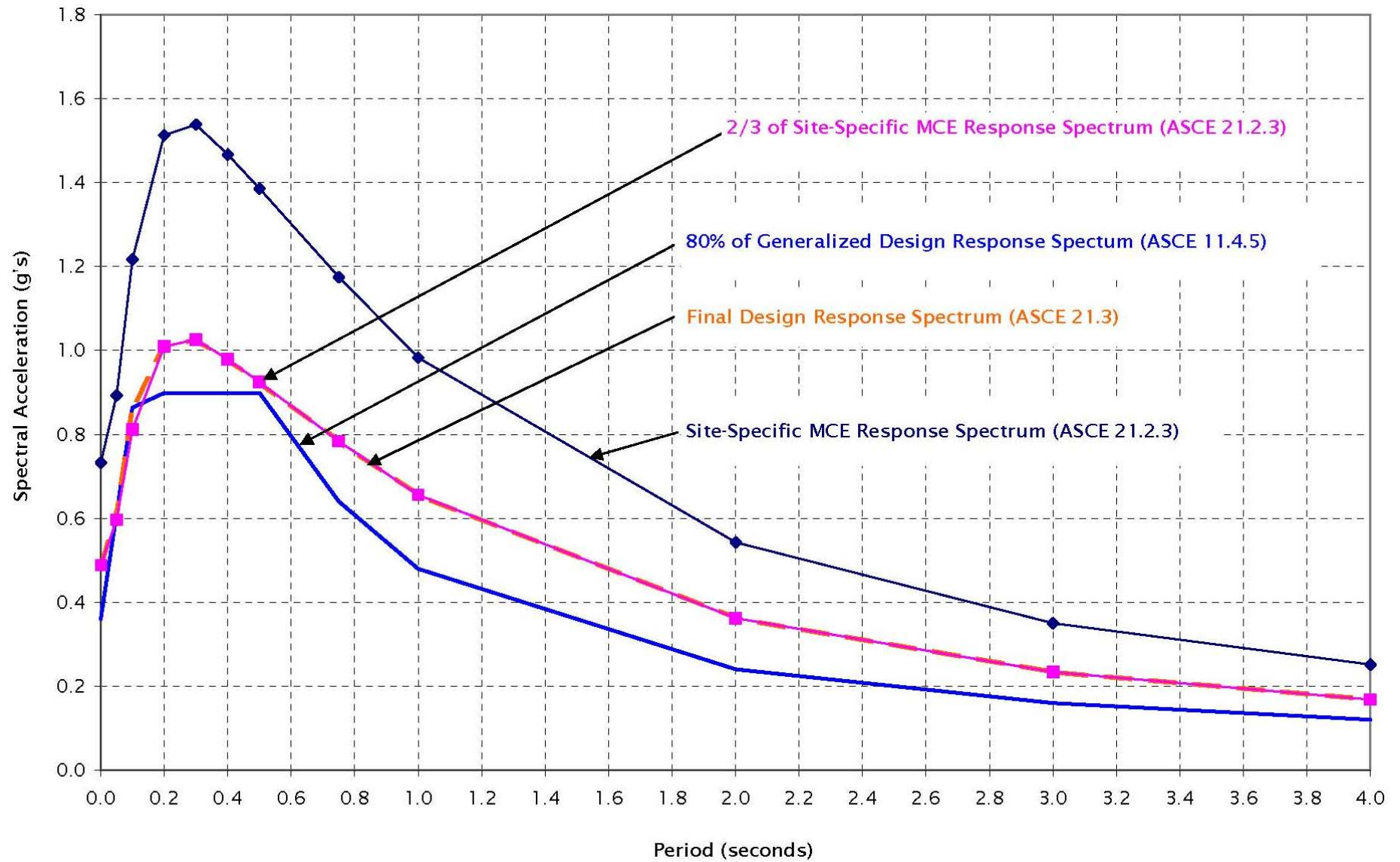
##### Zones of Required Investigation:

###### Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.







## APPENDIX A

## **APPENDIX A**

### **FIELD EXPLORATIONS**

#### **GENERAL**

We explored subsurface conditions at the site of the proposed library and the proposed parking lot by drilling four borings (B-1 through B-4) to depths of 10.5 to 36.5 feet BGS at the approximate location shown on Figure 2. JDK Drilling of Orange, California, drilled the borings using a limited access drill rig equipped for hollow-stem auger drilling methods on July 22, 2010.

The locations of the explorations were determined in the field by measuring from surveyed existing site features. This information should be considered accurate only to the degree implied by the methods used.

A member of our geotechnical staff observed and logged the explorations. We obtained representative samples of the various soils encountered in the explorations for geotechnical laboratory testing. Classifications and sampling intervals are shown on the exploration logs included in this appendix.

#### **SOIL SAMPLING**

Samples were obtained from the explorations using a modified California split-spoon sampler in general accordance with guidelines presented in ASTM D 3550. The split-spoon samplers were driven into the soil with a 140-pound hammer free-falling 30 inches. The samplers were driven a total distance of 18 inches or to refusal as indicated on the exploration logs. The number of blows required to drive the sampler the final 12 inches is recorded on the exploration logs included in this appendix, unless otherwise noted.

In addition, SPTs were performed in the explorations in general accordance with ASTM D 1586. The 2-inch-diameter, split-spoon sampler was driven into the soil with a 140-pound hammer free-falling 30 inches. The samplers were driven a total distance of 18 inches or to refusal. The number of blows required to drive the sampler the final 12 inches is recorded on the exploration logs included in this appendix.

#### **SOIL CLASSIFICATION**

The soil samples were classified in accordance with the "Exploration Key" (Table A-1) and "Soil Classification System" (Table A-2), which are included in this appendix. The exploration logs indicates the depths at which the soils or their characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications and sampling intervals are presented on the exploration logs included in this appendix.



## **LABORATORY TESTING**

### ***CLASSIFICATION***

The soil samples were classified in the laboratory to confirm field classifications. If those classifications differed from the field classifications, the laboratory classifications are presented on the exploration logs.

### ***MOISTURE CONTENT***

We tested the natural moisture content of selected samples obtained from the exploration in general accordance with ASTM D 2216. The natural moisture content is a ratio of the weight of the water to soil in a test sample and is expressed as a percentage. The moisture contents are presented on the exploration logs included in this appendix.

### ***DRY DENSITY***

We tested selected soil samples to determine the in situ dry density. The tests were performed in general accordance with ASTM D 2937. The dry density is defined as the ratio of the dry weight of the soil sample to the volume of that sample. The dry density typically is expressed in units of pcf. The dry densities are presented on the exploration logs included in this appendix.

### ***MAXIMUM DENSITY AND OPTIMUM MOISTURE CONTENT DETERMINATIONS***









Maximum dry density and optimum moisture content were determined in accordance with ASTM D 1557 on the bulk sample collected from boring B-1. The result of the test is presented on Figure A-5 in this appendix.

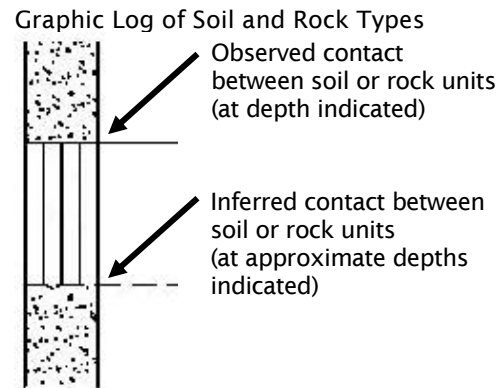
### ***CONSOLIDATION TESTING***

We performed one consolidation test in general accordance with ASTM D 2435 on relatively undisturbed samples obtained from the explorations. The tests measure the volume change of a soil sample under predetermined loads. The results of the consolidation tests are presented on Figure A-6 in this appendix.

### ***STRENGTH TESTING***

Direct shear tests were completed on three undisturbed soil samples obtained from the explorations. The tests were conducted in general accordance with ASTM D 3080. The results of the direct shear tests are presented on Figure A-7 in this appendix.

SYMBOL	SAMPLING DESCRIPTION
	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
	Location of sample obtained using Dames & Moore or 3-inch-O.D. split-spoon sampler and 140-pound hammer or pushed with recovery
	Location of grab sample
	Rock coring interval
	Water level during drilling
	Water level taken on date shown




#### GEOTECHNICAL TESTING EXPLANATIONS

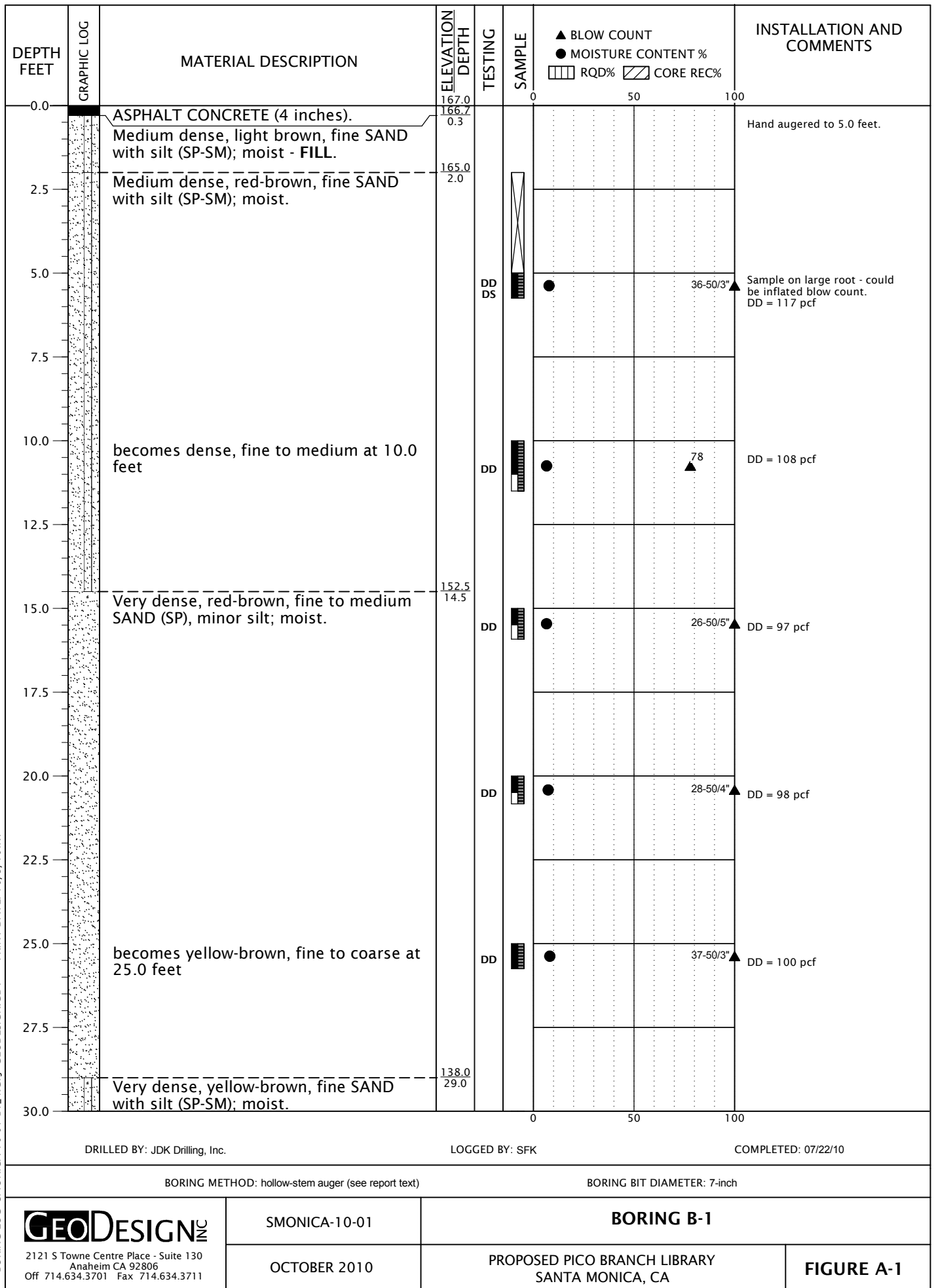
ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density	RES	Resilient Modulus
DS	Direct Shear	SIEV	Sieve Gradation
HYD	Hydrometer Gradation	TOR	Torvane
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

#### ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
ppm	Parts per Million	MS	Moderate Sheen
		HS	Heavy Sheen

RELATIVE DENSITY - COARSE-GRAINED SOILS															
Relative Density		Standard Penetration Resistance		Dames & Moore Sampler (140-pound hammer)		Dames & Moore Sampler (300-pound hammer)									
Very Loose		0 - 4		0 - 11		0 - 4									
Loose		4 - 10		11 - 26		4 - 10									
Medium Dense		10 - 30		26 - 74		10 - 30									
Dense		30 - 50		74 - 120		30 - 47									
Very Dense		More than 50		More than 120		More than 47									
CONSISTENCY - FINE-GRAINED SOILS															
Consistency		Standard Penetration Resistance		Dames & Moore Sampler (140-pound hammer)		Dames & Moore Sampler (300-pound hammer)		Unconfined Compressive Strength (tsf)							
Very Soft		Less than 2		Less than 3		Less than 2		Less than 0.25							
Soft		2 - 4		3 - 6		2 - 5		0.25 - 0.50							
Medium Stiff		4 - 8		6 - 12		5 - 9		0.50 - 1.0							
Stiff		8 - 15		12 - 25		9 - 19		1.0 - 2.0							
Very Stiff		15 - 30		25 - 65		19 - 31		2.0 - 4.0							
Hard		More than 30		More than 65		More than 31		More than 4.0							
PRIMARY SOIL DIVISIONS				GROUP SYMBOL		GROUP NAME									
COARSE-GRAINED SOILS  (more than 50% retained on No. 200 sieve)		GRAVEL  (more than 50% of coarse fraction retained on No. 4 sieve)		CLEAN GRAVELS (< 5% fines)		GW or GP		GRAVEL							
				GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)		GW-GM or GP-GM		GRAVEL with silt							
						GW-GC or GP-GC		GRAVEL with clay							
				GRAVELS WITH FINES (> 12% fines)		GM		silty GRAVEL							
						GC		clayey GRAVEL							
						GC-GM		silty, clayey GRAVEL							
		SAND  (50% or more of coarse fraction passing No. 4 sieve)		CLEAN SANDS (<5% fines)		SW or SP		SAND							
				SANDS WITH FINES (≥ 5% and ≤ 12% fines)		SW-SM or SP-SM		SAND with silt							
						SW-SC or SP-SC		SAND with clay							
				SANDS WITH FINES (> 12% fines)		SM		silty SAND							
						SC		clayey SAND							
						SC-SM		silty, clayey SAND							
				FINE-GRAINED SOILS  (50% or more passing No. 200 sieve)		Liquid limit less than 50		ML		SILT					
CL		CLAY													
CL-ML		silty CLAY													
OL		ORGANIC SILT or ORGANIC CLAY													
Liquid limit 50 or greater		MH				SILT									
		CH				CLAY									
		OH				ORGANIC SILT or ORGANIC CLAY									
HIGHLY ORGANIC SOILS				PT		PEAT									
MOISTURE CLASSIFICATION			ADDITIONAL CONSTITUENTS												
Term		Field Test		Secondary granular components or other materials such as organics, man-made debris, etc.											
				Percent		Silt and Clay In:		Percent		Sand and Gravel In:					
						Fine-Grained Soils		Coarse-Grained Soils				Fine-Grained Soils		Coarse-Grained Soils	
dry		very low moisture, dry to touch		< 5		trace		trace		< 5		trace		trace	
moist		damp, without visible moisture		5 - 12		minor		with		5 - 15		minor		minor	
wet		visible free water, usually saturated		> 12		some		silty/clayey		15 - 30		with		with	
										> 30		sandy/gravelly		sandy/gravelly	
 2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711			SOIL CLASSIFICATION SYSTEM									TABLE A-2			

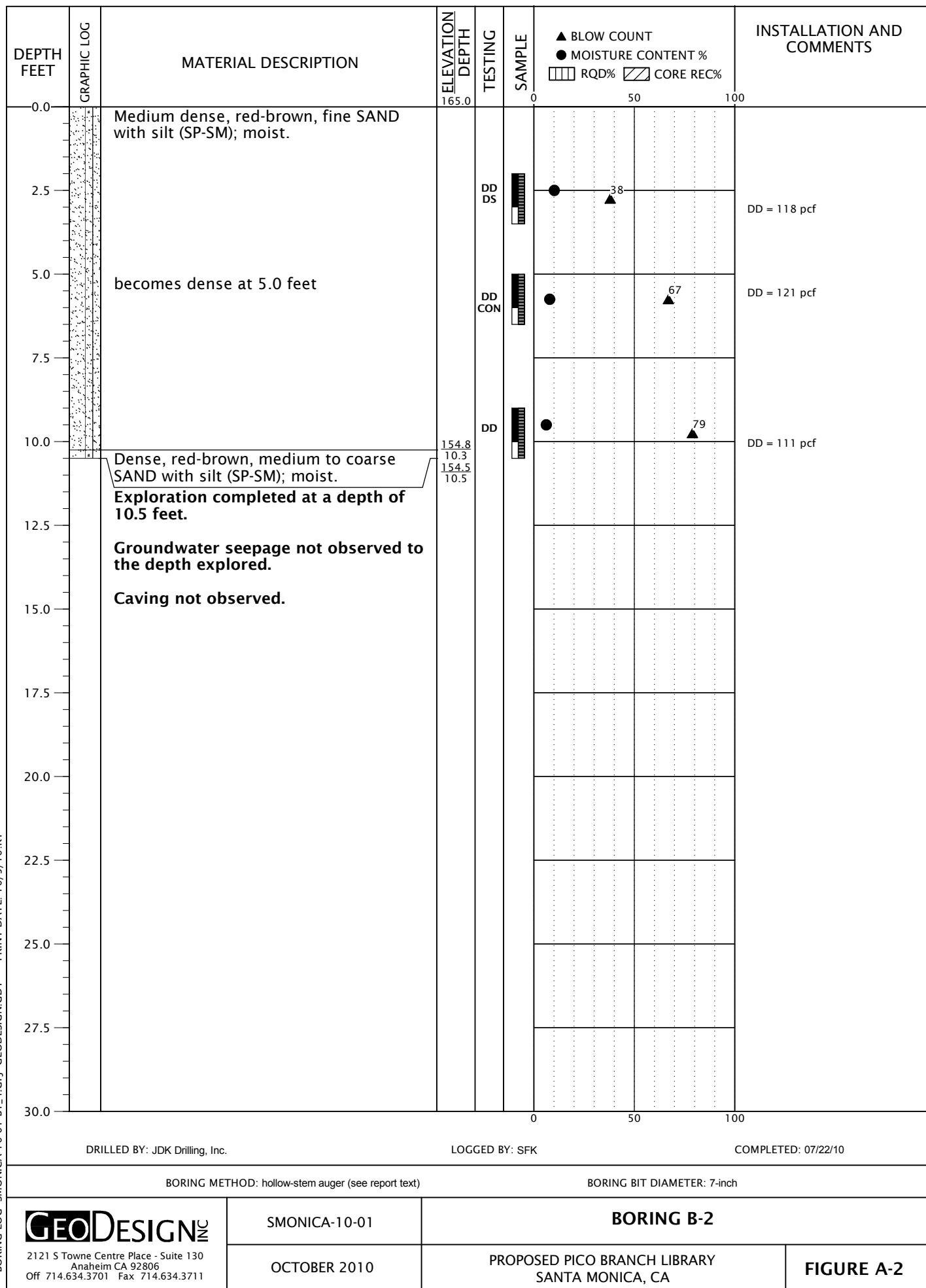
BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT



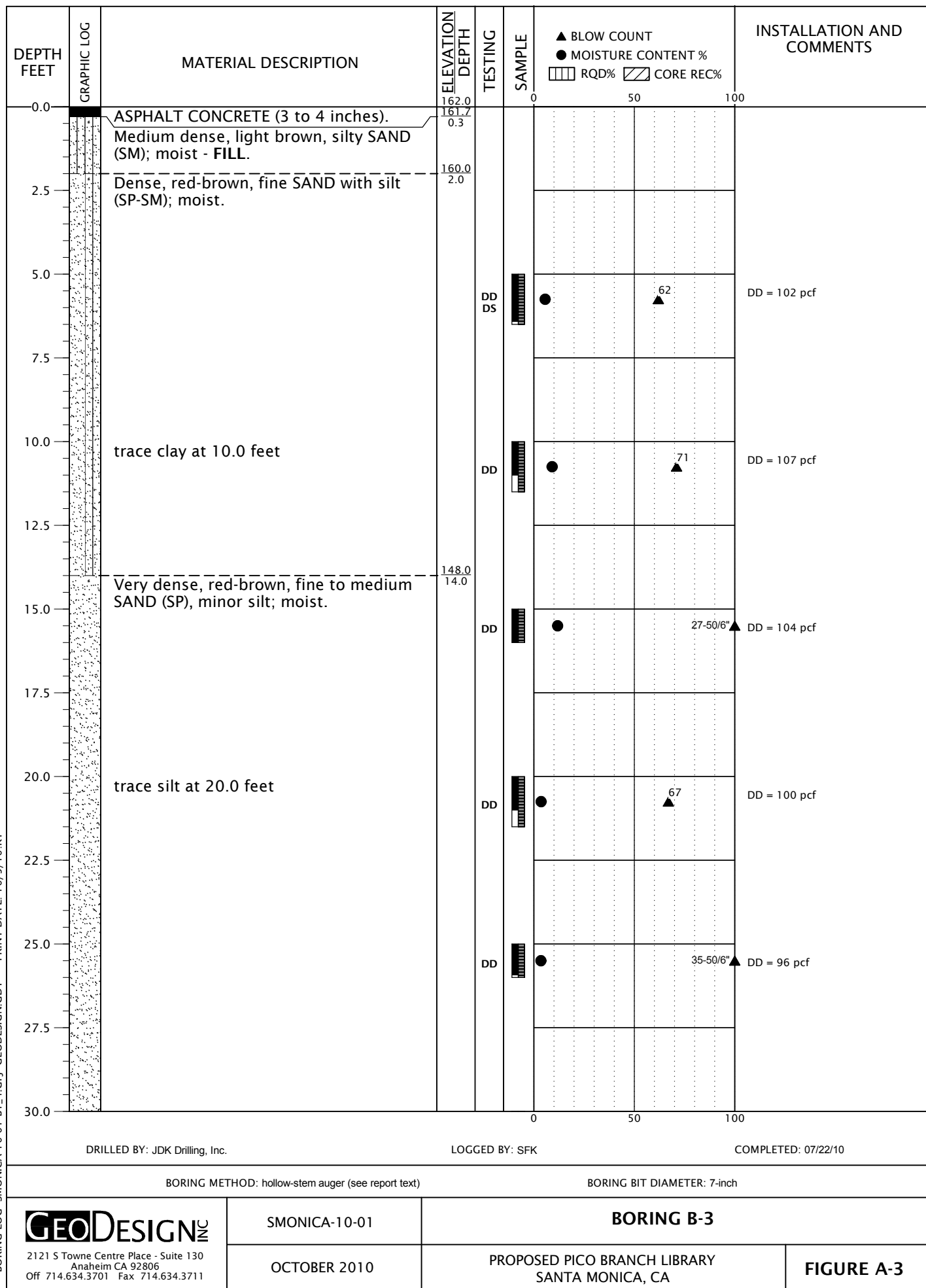
BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
30.0		(continued from previous page)		DD		0 50 100	DD = 88 pcf
32.5							
35.0				DD		0 50 100	DD = 88 pcf
37.5		Exploration completed at a depth of 36.5 feet.	130.5 36.5				
40.0		Groundwater seepage not observed to the depth explored.					
42.5		Caving not observed.					
45.0							
47.5							
50.0							
52.5							
55.0							
57.5							
60.0						0 50 100	
DRILLED BY: JDK Drilling, Inc.		LOGGED BY: SFK		COMPLETED: 07/22/10			
BORING METHOD: hollow-stem auger (see report text)				BORING BIT DIAMETER: 7-inch			
<div>GeoDesign</div> <div>2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711</div>		SMONICA-10-01	BORING B-1 (continued)			FIGURE A-1	
		OCTOBER 2010	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA				

BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT



BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT



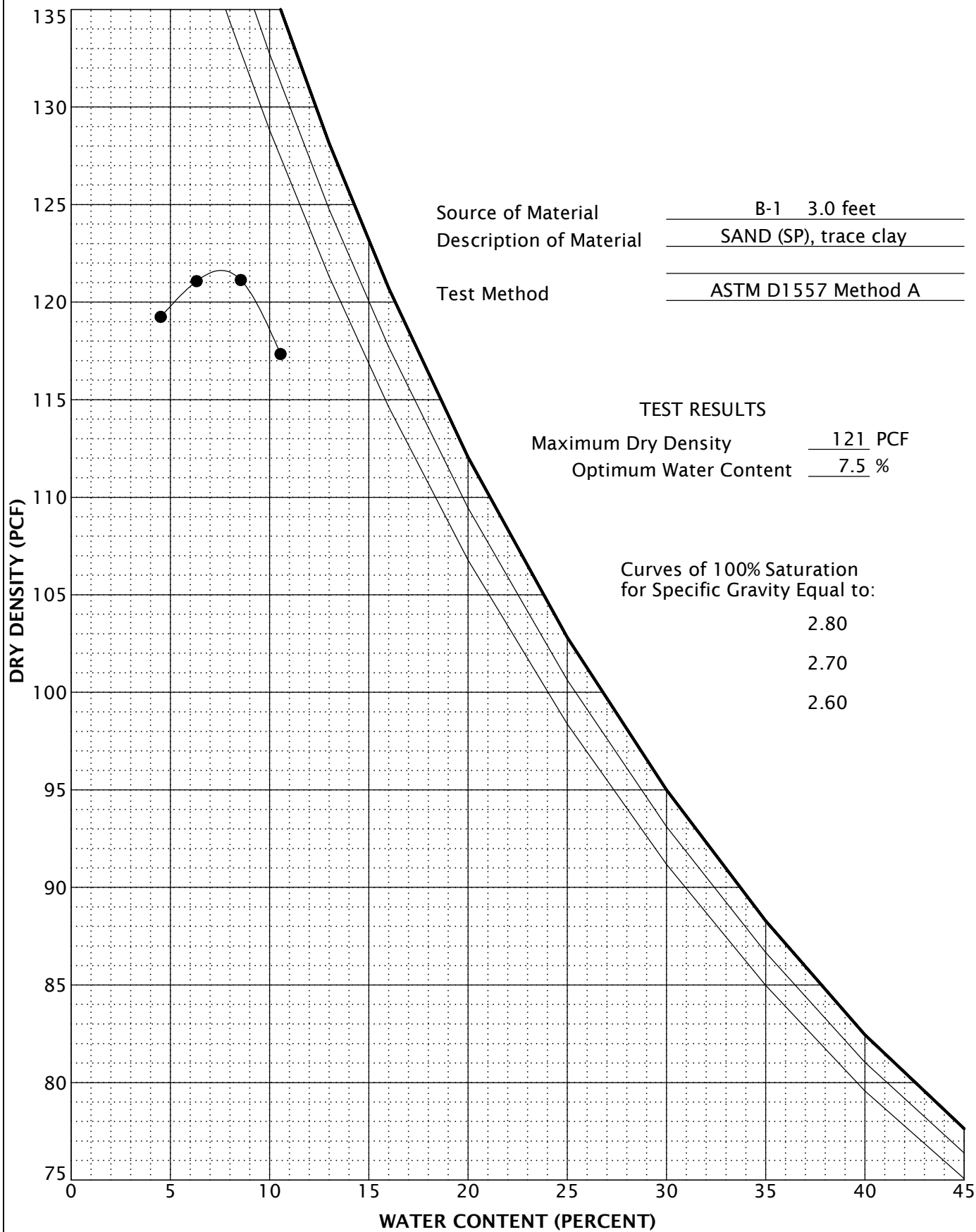
BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
30.0		minor silt at 30.0 feet				0 50 100	
32.5							
35.0							
36.5		Exploration completed at a depth of 36.5 feet.	125.5 36.5				
37.5		Groundwater seepage not observed to the depth explored.					
40.0		Caving not observed.					
42.5							
45.0							
47.5							
50.0							
52.5							
55.0							
57.5							
60.0						0 50 100	
DRILLED BY: JDK Drilling, Inc.			LOGGED BY: SFK			COMPLETED: 07/22/10	
BORING METHOD: hollow-stem auger (see report text)			BORING BIT DIAMETER: 7-inch				
<div>GeoDesign</div> <div>2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711</div>		SMONICA-10-01	BORING B-3 (continued)				
		OCTOBER 2010	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA				
						FIGURE A-3	



BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 10/5/10:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % ▤ RQD% ▨ CORE REC%	INSTALLATION AND COMMENTS
0.0		LAWN (driving turf with reinforcing grid, 3 inches).	168.0		0		
		Medium dense, light-brown, silty SAND (SM); moist - FILL.	167.7 0.3				
2.5		Dense, brown, fine to medium SAND with silt (SP-SM); moist.	167.0 1.0				
						28-50/4"	▲
5.0		Dense, red-brown, fine SAND (SP), minor silt; moist.	163.5 4.5			56	▲
7.5							
10.0		becomes very dense, fine to medium at 10.0 feet				45-50/6"	▲
		Exploration completed at a depth of 11.5 feet.	156.5 11.5				
12.5		Groundwater seepage not observed to the depth explored.					
15.0		Caving not observed.					
17.5							
20.0							
22.5							
25.0							
27.5							
30.0							
DRILLED BY: JDK Drilling, Inc.		LOGGED BY: SFK		COMPLETED: 07/22/10			
BORING METHOD: hand-auger (see report text)				BORING BIT DIAMETER: 7-inch			
<b>GEODESIGN</b> 2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711		SMONICA-10-01	BORING B-4				
		OCTOBER 2010	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA				FIGURE A-4



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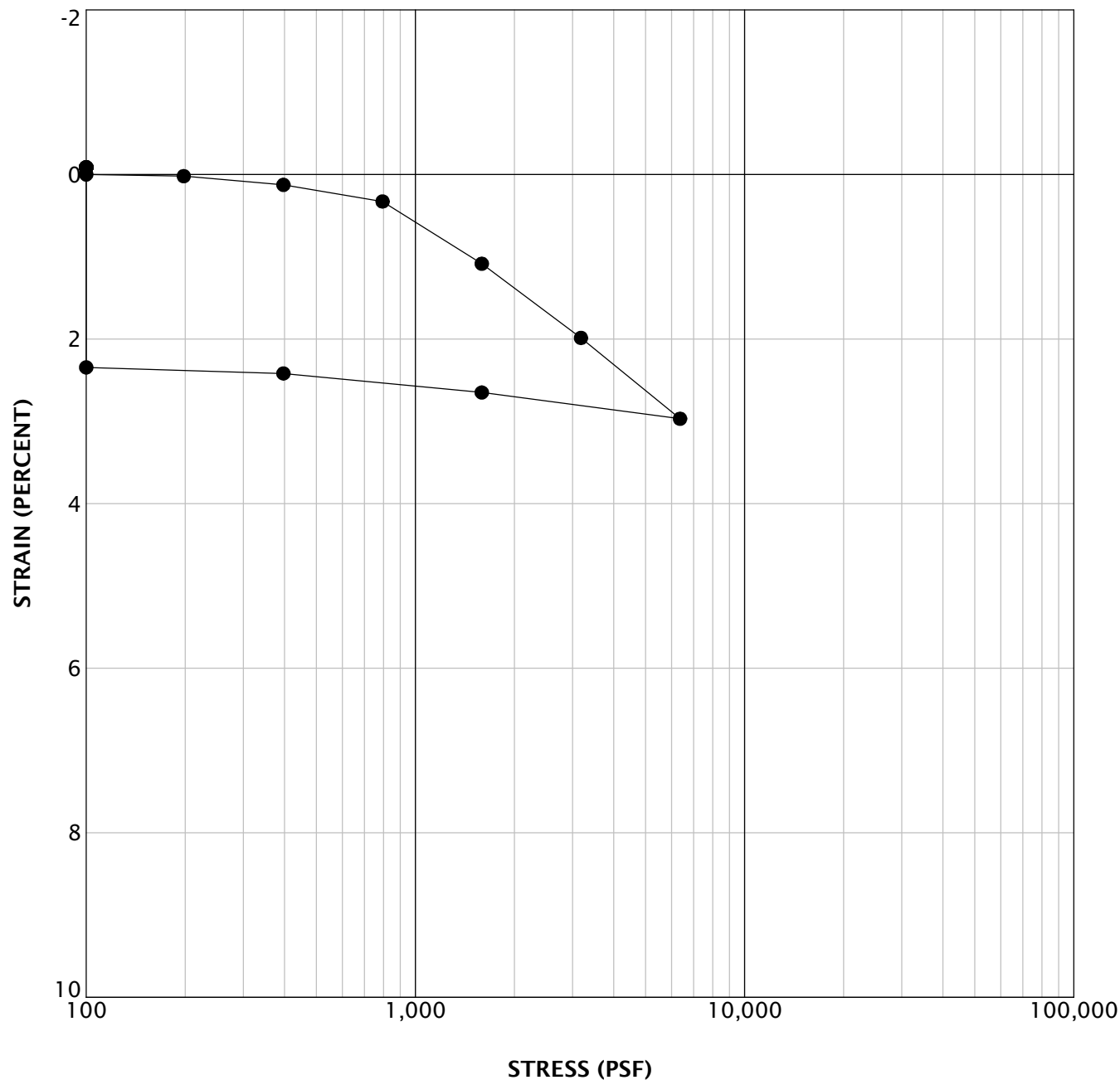
SMONICA-10-01

OCTOBER 2010

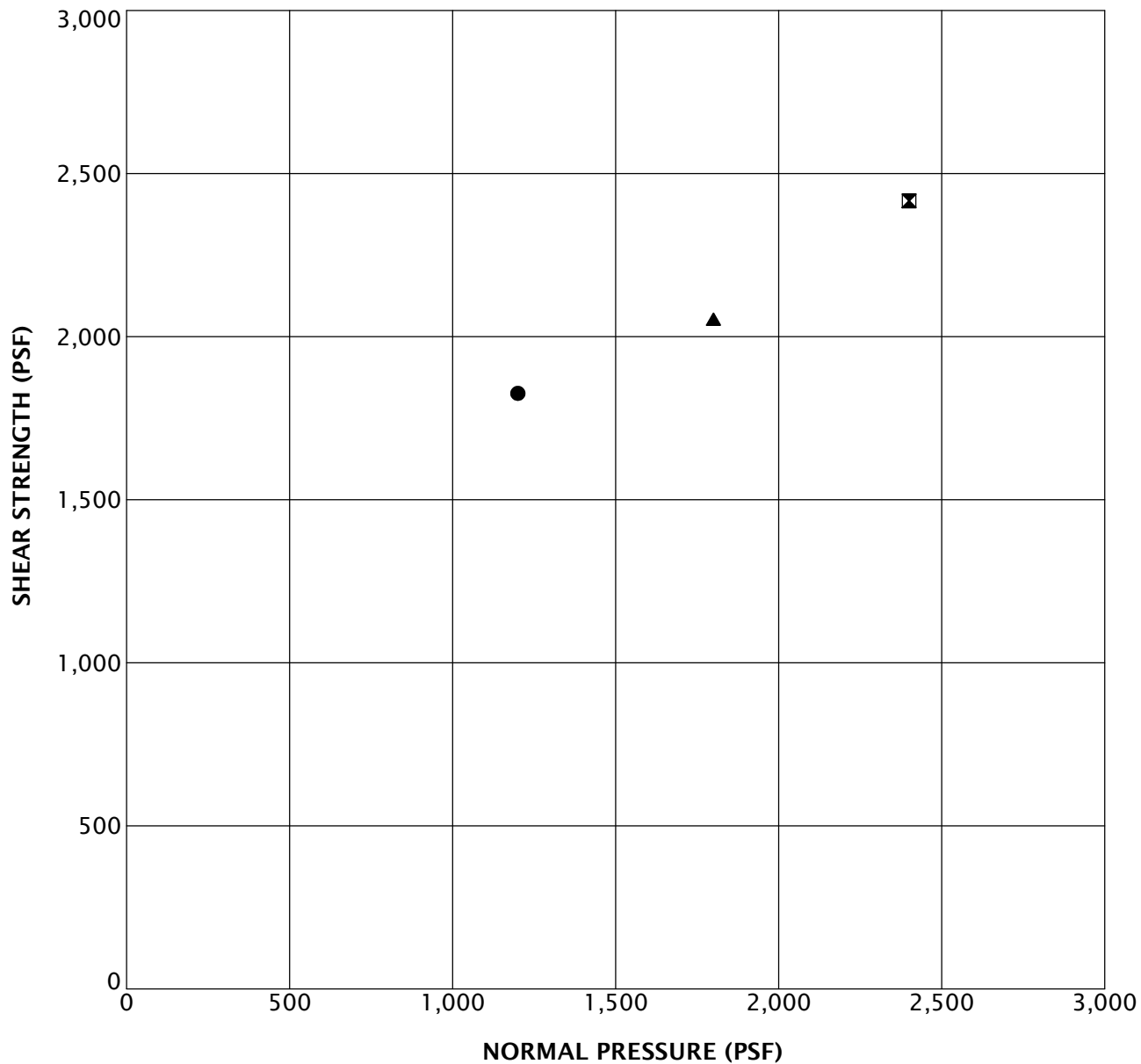
### MOISTURE-DENSITY RELATIONSHIP

PROPOSED PICO BRANCH LIBRARY  
 SANTA MONICA, CA


FIGURE A-5



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)
●	B-2	5.0	8	121



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SOAKED
●	B-1	5.0	8	117	YES
⊠	B-2	2.5	10	118	YES
▲	B-3	5.0	6	102	YES

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT (PERCENT)	PLASTIC LIMIT (PERCENT)	PLASTICITY INDEX (PERCENT)
B-1	5.0	162.0	8	117						
B-1	10.0	157.0	7	108						
B-1	15.0	152.0	7	97						
B-1	20.0	147.0	7	98						
B-1	25.0	142.0	8	100						
B-1	30.0	137.0	12	88						
B-1	35.0	132.0	7	88						
B-2	2.5	162.5	10	118						
B-2	5.0	160.0	8	121						
B-2	9.5	155.5	6	111						
B-3	5.0	157.0	6	102						
B-3	10.0	152.0	9	107						
B-3	15.0	147.0	12	104						
B-3	20.0	142.0	4	100						
B-3	25.0	137.0	3	96						
 2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711			SMONICA-10-01		SUMMARY OF LABORATORY DATA					
			OCTOBER 2010		PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA				FIGURE A-8	



AP Engineering & Testing, Inc.

## EXPANSION INDEX TEST RESULTS

ASTM D 4829

Client Name: GeoDesign Inc.  
Project Name: Smonica-10-1  
Project No.: Smonica-10-1

AP Job No.: 10-0848  
Date: 08/19/10

Boring No.	Sample No.	Depth (ft)	Soil Description	Molded Dry Density (pcf)	Molded Moisture Content (%)	Init. Degree Saturation (%)	Measured Expansion Index	Corrected Expansion Index
B-1	-	2-5	Strong Brown Silty Sand	111.7	8.7	46.1	0	0

### ASTM EXPANSION CLASSIFICATION

Expansion Index	Classification
0-20	V. Low
21-50	Low
51-90	Medium
91-130	High
>130	V. High



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## **TRANSMITTAL LETTER**


**DATE:** August 18, 2010

**ATTENTION:** Chris Zadoorian

**TO:** GeoDesign, Inc.  
2121 South Towne Center Place, #130  
Anaheim, CA 92806

**SUBJECT:** Laboratory Test Data  
Pico Branch Library  
Your #smonica-10-1, SA #10-0830LAB

**COMMENTS:** Enclosed are the results for the subject project.

  
\_\_\_\_\_  
Leo Solis  
Laboratory Manager

**Table 1 - Laboratory Tests on Soil Sample(s)***GeoDesign, Inc.**Pico Branch Library**Your #smonica-10-1, SA #10-0830LAB**9-Aug-10*

**Sample ID** B-1  
@ 2-4'  
Silty Sand

Resistivity	Units	
as-received	ohm-cm	15,200
saturated	ohm-cm	4,400

<b>pH</b>		8.1
-----------	--	-----

**Electrical**

<b>Conductivity</b>	mS/cm	0.06
---------------------	-------	------

**Chemical Analyses****Cations**

calcium	Ca <sup>2+</sup>	mg/kg	31
magnesium	Mg <sup>2+</sup>	mg/kg	8.1
sodium	Na <sup>1+</sup>	mg/kg	53
potassium	K <sup>1+</sup>	mg/kg	2.2

**Anions**

carbonate	CO <sub>3</sub> <sup>2-</sup>	mg/kg	ND
bicarbonate	HCO <sub>3</sub> <sup>1-</sup>	mg/kg	92
fluoride	F <sup>1-</sup>	mg/kg	3.4
chloride	Cl <sup>1-</sup>	mg/kg	13
sulfate	SO <sub>4</sub> <sup>2-</sup>	mg/kg	33
phosphate	PO <sub>4</sub> <sup>3-</sup>	mg/kg	11

**Other Tests**

ammonium	NH <sub>4</sub> <sup>1+</sup>	mg/kg	ND
nitrate	NO <sub>3</sub> <sup>1-</sup>	mg/kg	1.1
sulfide	S <sup>2-</sup>	qual	na
Redox		mV	na

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.  
mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed



- ANALYSIS
- DESIGN

# LaBelle • Marvin

- SOILS, ASPHALT  
TECHNOLOGY

## PROFESSIONAL PAVEMENT ENGINEERING

A CALIFORNIA CORPORATION

August 12, 2010

*Mr. Chris Zadoorian*  
**GeoDesign, Inc.**

2121 S. Towne Centre Place Suite 130  
Anaheim, California 92806

Project No. 37103

Dear Mr. Zadoorian:

Laboratory testing of the bulk soil sample submitted to our laboratory on 8/6/10 has been completed. Results are tabulated herein and R-Value Data Sheets are transmitted herewith. Any untested portion of the sample will be retained for a period of 60 days prior to disposal.

**Smonica-10-01**  
R-Value (CA 301)

**B-4 @ 1'-3'**  
69 by Exudation

The opportunity to be of service is appreciated and should you have any questions, kindly call.

Very truly yours,



**Steven R. Marvin**  
RCE 30659


SRM:mm  
Enclosures

# R - VALUE DATA SHEET

Smonica-10-01

PROJECT NUMBER 37103 BORING NUMBER: B-4 @ 1'-3'

SAMPLE DESCRIPTION: Brown Silty Sand

Item	SPECIMEN		
	a	b	c
Mold Number	1	2	3
Water added, grams	56	36	44
Initial Test Water, %	9.6	7.9	8.6
Compact Gage Pressure, psi	65	315	210
Exudation Pressure, psi	212	793	366
Height Sample, Inches	2.66	2.58	2.63
Gross Weight Mold, grams	3172	3130	3164
Tare Weight Mold, grams	1965	1969	1977
Sample Wet Weight, grams	1207	1161	1187
Expansion, Inches x 10exp-4	0	9	3
Stability 2,000 lbs (160psi)	22 / 42	13 / 24	15 / 29
Turns Displacement	5.06	4.73	4.97
R-Value Uncorrected	58	75	69
R-Value Corrected	62	76	72
Dry Density, pcf	125.4	126.4	126.0
<b>DESIGN CALCULATION DATA</b>			
Traffic Index	Assumed: 4.0	4.0	4.0
G.E. by Stability	0.39	0.25	0.29
G. E. by Expansion	0.00	0.30	0.10
<b>Equilibrium R-Value</b>	<b>69</b> by <b>EXUDATION</b>	Examined & Checked: 8 /10/ 10	
<b>REMARKS:</b>	Gf = 1.25		
	Partial Free Drainage.		
<p>The data above is based upon processing and testing samples as received from the field. Test procedures in accordance with latest revisions to Department of Transportation, State of California, Materials &amp; Research Test Method No. 301.</p>			



# R-VALUE GRAPHICAL PRESENTATION

PROJECT NO. 37103

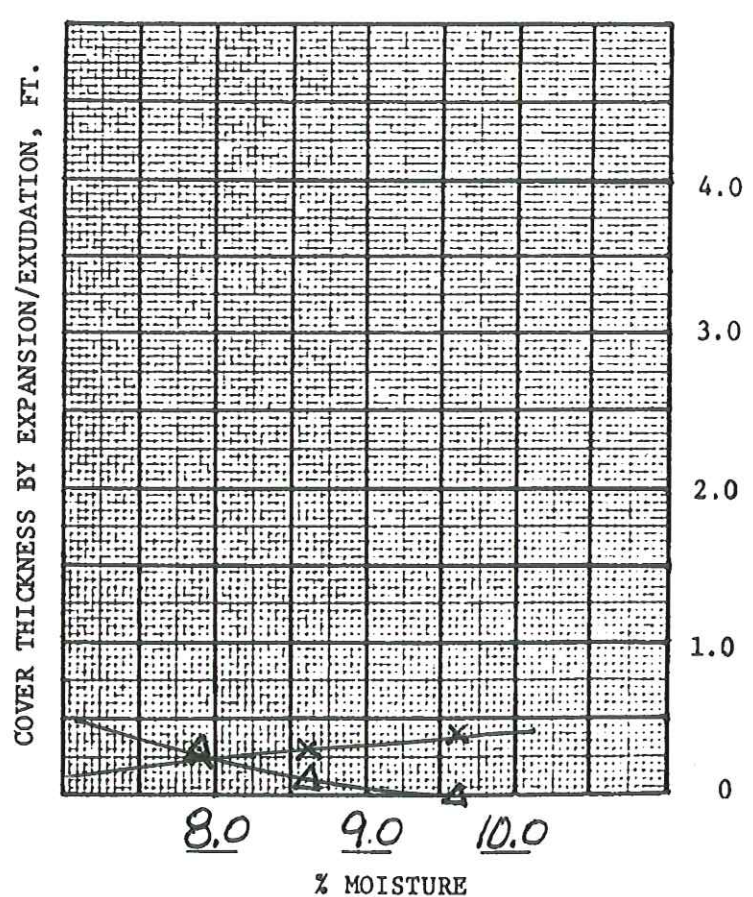
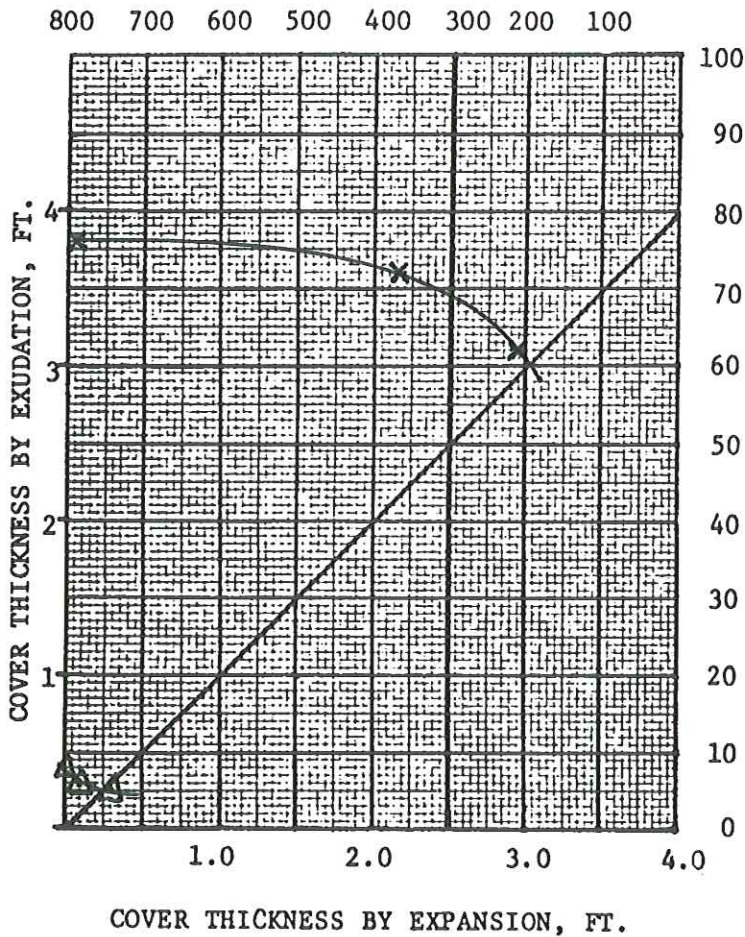
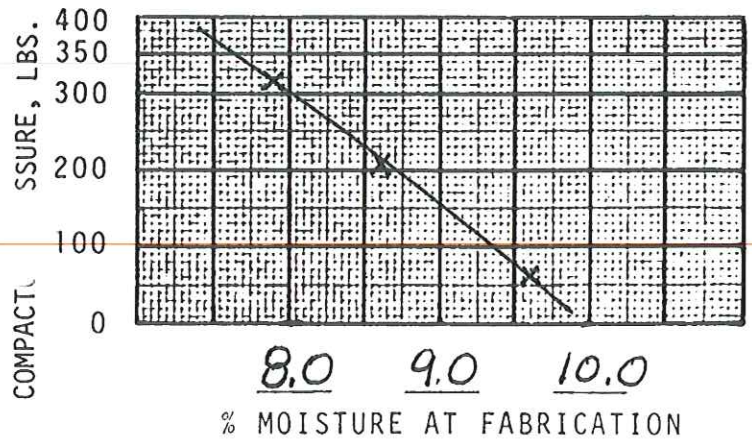
BORING NO. Smonica 10-01  
B-4 @ 1'-3"

DATE 8/10/10

TRAFFIC INDEX Assumed 4.0

R-VALUE BY EXUDATION 69

R-VALUE BY EXPANSION -



R-VALUE vs. EXUD. PRES.

T by EXUDATION

EXUD. T vs. EXPAN. T

T by EXPANSION

REMARKS

Gf = 1.25

## **APPENDIX B**

## **APPENDIX B**

### **INFILTRATION TESTING**

Infiltration testing was performed using the falling-head test method. This method includes filling the PVC casing with water and recording the water level drop over regular time intervals.

Prior to performing the actual infiltration test, "pre-soaking" was performed. Pre-soaking consists of filling the PVC casing with water to the ground surface and allowing the water to infiltrate into the soils. Testing is usually performed the day after the pre-soaking. However, if the soils are predominantly sand, then testing can be performed the same day.

The depth of the testing in the borings was set at a maximum depth of 10 feet BGS in the borings and was intended to evaluate the permeability of the upper granular materials. The screened interval was 0 to 10 feet BGS in boring B-2 and 0 to 9.4 feet in boring B-4.

After completion of the infiltration test, the PVC pipe was removed and the holes were backfilled with native soil to the ground surface.

#### ***TESTING METHODOLOGY***

To start the pre-soak, the hole was filled with clear water to the ground surface and water level readings were taken at time intervals of every 30 minutes. The water level was refilled to the ground surface after each reading. In each of four consecutive readings (two hours) in boring B-2, the water seepage was consistent and did not vary more than 10 percent. As a result of this condition, testing was initiated after the fourth reading (two hours) in boring B-2.

In boring B-4, the water seepage rate was more variable than in boring B-2. Seepage rates during the pre-soak varied as much as 30 percent. Although the rates were variable, we continued with the test due to the inability to leave the test hole open overnight in the park that is accessible to the public.

We measured and recorded the drop in water level every 30 minutes for a minimum of 300 minutes (five hours), refilling the hole to the surface with clear water between each reading. After several hours of consistent readings (eight timed intervals) defined as having less than 10 percent variance, the tests were considered complete.

# INFILTRATION TEST CALCULATIONS

**Boring Number:** B-2  
**Diameter of Hole:** 0.5833  
**Hours Pre-Soak:** 2.00  
**Time Pre-Soak Initiated:** 9:00  
**Depth of Bottom (Below Grade):** 9.40 feet  
**Name of Tester:** Susan Kirkgard  
**Date Tested:** 7/22/2010  
**Method to Prevent Caving:** Gravel Packing (none)

## PreSoak

t-initial	t-final	delta t (hours)	d-bottom (feet)	d-initial	d-final	delta d=F	Lave	D (feet)	Q (gal/sf/day)	seepage mpi	in/hour
9:00	9:30	0.50	9.40	0.00	2.31	2.31	8.25	0.5833	2.94	61.19	0.98
9:30	10:00	0.50	9.40	0.00	2.19	2.19	8.31	0.5833	2.77	65.01	0.92
10:00	10:30	0.50	9.40	0.00	2.29	2.29	8.26	0.5833	2.91	61.80	0.97
10:30	11:00	0.50	9.40	0.00	2.32	2.32	8.24	0.5833	2.96	60.89	0.99

t-initial	t-final	delta t (hours)	d-bottom (feet)	d-initial	d-final	delta d=F	Lave	D (feet)	Q (gal/sf/day)	seepage mpi	in/hour
11:00	11:30	0.5	9.40	0.00	2.39	2.39	8.21	0.5833	3.06	58.86	1.02
11:30	12:00	0.5	9.40	0.00	2.41	2.41	8.20	0.5833	3.09	58.30	1.03
12:00	12:30	0.5	9.40	0.00	2.35	2.35	8.23	0.5833	3.00	60.00	1.00
12:30	13:00	0.5	9.40	0.00	2.40	2.40	8.20	0.5833	3.07	58.57	1.02
13:00	13:30	0.5	9.40	0.00	2.52	2.52	8.14	0.5833	3.25	55.38	1.08
13:30	14:00	0.5	9.40	0.00	2.62	2.62	8.09	0.5833	3.40	52.94	1.13
14:00	14:30	0.5	9.40	0.00	2.45	2.45	8.18	0.5833	3.15	57.20	1.05
14:30	15:00	0.5	9.40	0.00	2.42	2.42	8.19	0.5833	3.10	58.02	1.03
15:00	15:30	0.5	9.40	0.00	2.45	2.45	8.18	0.5833	3.15	57.20	1.05
15:30	16:00	0.5	9.40	0.00	2.41	2.41	8.20	0.5833	3.09	58.30	1.03
AVERAGE										57.48	1.04

# INFILTRATION TEST CALCULATIONS

Boring Number: B-4  
 Diameter of Hole: 0.5833  
 Hours Pre-Soak: 2.00  
 Time Pre-Soak Initiated: 12:15  
 Depth of Bottom (Below Grade): 10.00  
 Name of Tester: Susan Kirkgard  
 Date Tested: 7/22/2010  
 Method to Prevent Caving: Gravel Packing (none)

## PreSoak

t-intial	t-final	delta t (hours)	d-bottom (feet)	d-initial	d-final	delta d=F	Lave	D (feet)	Q (gal/sf/day)	seepage mpi	in/hour
12:15	12:45	0.50	10.00	0.00	3.05	3.05	8.48	0.5833	3.78	47.64	1.26
12:45	13:15	0.50	10.00	0.00	3.00	3.00	8.50	0.5833	3.71	48.57	1.24
13:15	13:45	0.50	10.00	0.00	3.55	3.55	8.23	0.5833	4.53	39.72	1.51
13:45	14:15	0.50	10.00	0.00	2.62	2.62	8.69	0.5833	3.17	56.86	1.06

t-intial	t-final	delta t (hours)	d-bottom (feet)	d-initial	d-final	delta d=F	Lave	D (feet)	Q (gal/sf/day)	seepage mpi	in/hour
14:15	14:45	0.50	10.00	0.00	2.95	2.95	8.53	0.5833	3.63	49.54	1.21
14:45	15:15	0.50	10.00	0.00	3.08	3.08	8.46	0.5833	3.82	47.09	1.27
15:15	15:45	0.50	10.00	0.00	3.09	3.09	8.46	0.5833	3.84	46.91	1.28
15:45	16:15	0.50	10.00	0.00	3.39	3.39	8.31	0.5833	4.29	42.00	1.43
16:15	16:45	0.50	10.00	0.00	3.20	3.20	8.40	0.5833	4.00	45.00	1.33
16:45	17:15	0.50	10.00	0.00	2.96	2.96	8.52	0.5833	3.65	49.35	1.22
17:15	17:45	0.50	10.00	0.00	2.75	2.75	8.63	0.5833	3.35	53.77	1.12
17:45	18:15	0.50	10.00	0.00	2.80	2.80	8.60	0.5833	3.42	52.66	1.14
18:15	18:45	0.50	10.00	0.00	2.85	2.85	8.58	0.5833	3.49	51.58	1.16
18:45	19:15	0.50	10.00	0.00	2.80	2.80	8.60	0.5833	3.42	52.66	1.14
AVERAGE										49.06	1.22

## ACRONYMS



## ACRONYMS

AC	asphalt concrete
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BGS	below ground surface
CBC	California Building Code
CDMG	California Division of Mines and Geology
CGS	California Geological Survey
g	gravitational acceleration (32.2 feet/second <sup>2</sup> )
IBC	International Building Code
MCE	maximum considered earthquake
NGA	next generation attenuation
PCC	portland concrete cement
pcf	pounds per cubic foot
psf	pounds per square foot
PSHA	Probabilistic Seismic Hazard Assessment
psi	pounds per square inch
PVC	polyvinyl chloride
SPT	Standard Penetration Test

To:	Tom Afschar, AIA, CASp	From:	Susan Kirkgard and Chris Zadoorian
Company:	City of Santa Monica Architecture Services	Date:	October 27, 2011
Address:	1437 4 <sup>th</sup> Street, Suite 300 Santa Monica, CA 90401		
cc:	n/a		
GDI Project:	SMonica-10-01		
RE:	Proposed Santa Monica Pico Branch Library		

Original File Name	Date	Document Title
SMonica-10-01-100810-geor.doc	10/8/10	Report of Geotechnical Engineering Services; proposed Santa Monica Pico Branch Library; Virginia Avenue Park; Santa Monica, California; Special Provisions Number 2119

Addendum Number	Date	Description
1	10/27/11	Geotechnical Recommendations for Temporary Excavations (attached)

kt

Attachments

Six copies submitted

Document ID: SMonica-10-01-102711-geotat-1.doc

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October 27, 2011

City of Santa Monica  
Architecture Services  
1437 4<sup>th</sup> Street, Suite 300  
Santa Monica, CA 90401

Attention: Mr. Tom Afschar, AIA, CAsp

**Addendum 1**  
**Geotechnical Recommendations for Temporary Excavations**  
Proposed Santa Monica Pico Branch Library  
Virginia Avenue Park  
Santa Monica, California  
GeoDesign Project: SMonica-10-01

## **INTRODUCTION**

We performed a geotechnical investigation for the proposed Santa Monica Pico Branch Library to be constructed within Virginia Avenue Park located at the northwest corner of Pico Boulevard and Cloverfield Boulevard in Santa Monica, California. The results of our investigation were submitted in a report dated October 8, 2010.

The proposed project consists of constructing a 7,500-square-foot, at-grade branch library building and adjacent surface parking to accommodate 30 vehicles.

At the time our report was prepared, the exact library building footprint was not determined. Since that time, the proposed library building footprint has been established to be immediately east of the existing Thelma Terry Community Center Building as shown on the attached Figure 1.

As a result, foundation excavations for the proposed library building will undermine the existing foundations. You have furnished us with sketches prepared by Thorton-Tomasetti that depict the existing conditions and we anticipate that the proposed library foundation bottom will be approximately 1 to 2 feet below the bottom of the existing community center building foundation.

This addendum presents recommendations for the temporary excavations necessary to construct the foundation for the proposed library along the west side.

## RECOMMENDATIONS FOR TEMPORARY EXCAVATIONS - SLOT CUTTING

One method for constructing the temporary excavation for the new library foundation is slot cutting. Slot cutting refers to sequencing an excavation for continuous footings.

To accomplish the slot cutting, the library building foundation should be divided up into 5-foot-long sections and each three consecutive sections should be labeled A, B, and C as shown on Figure 1.

The excavation may be conducted sequentially, first by excavation of slot A sections. Upon completion of the Section A excavations, the foundation should be constructed in the slot A sections.

The process should then be repeated for slot B sections, and then again for slot C sections to complete the foundation construction.

♦ ♦ ♦

It is our pleasure to provide continued geotechnical consultation services for the proposed Santa Monica Pico Branch Library. Please contact us with any questions or comments regarding this addendum.

Sincerely,

GeoDesign, Inc.



Susan F. Kirkgard, C.E.G.  
Associate Geologist



Christopher J. Zadoorian, G.E.  
Principal Engineer



SFK:CJZ:kt

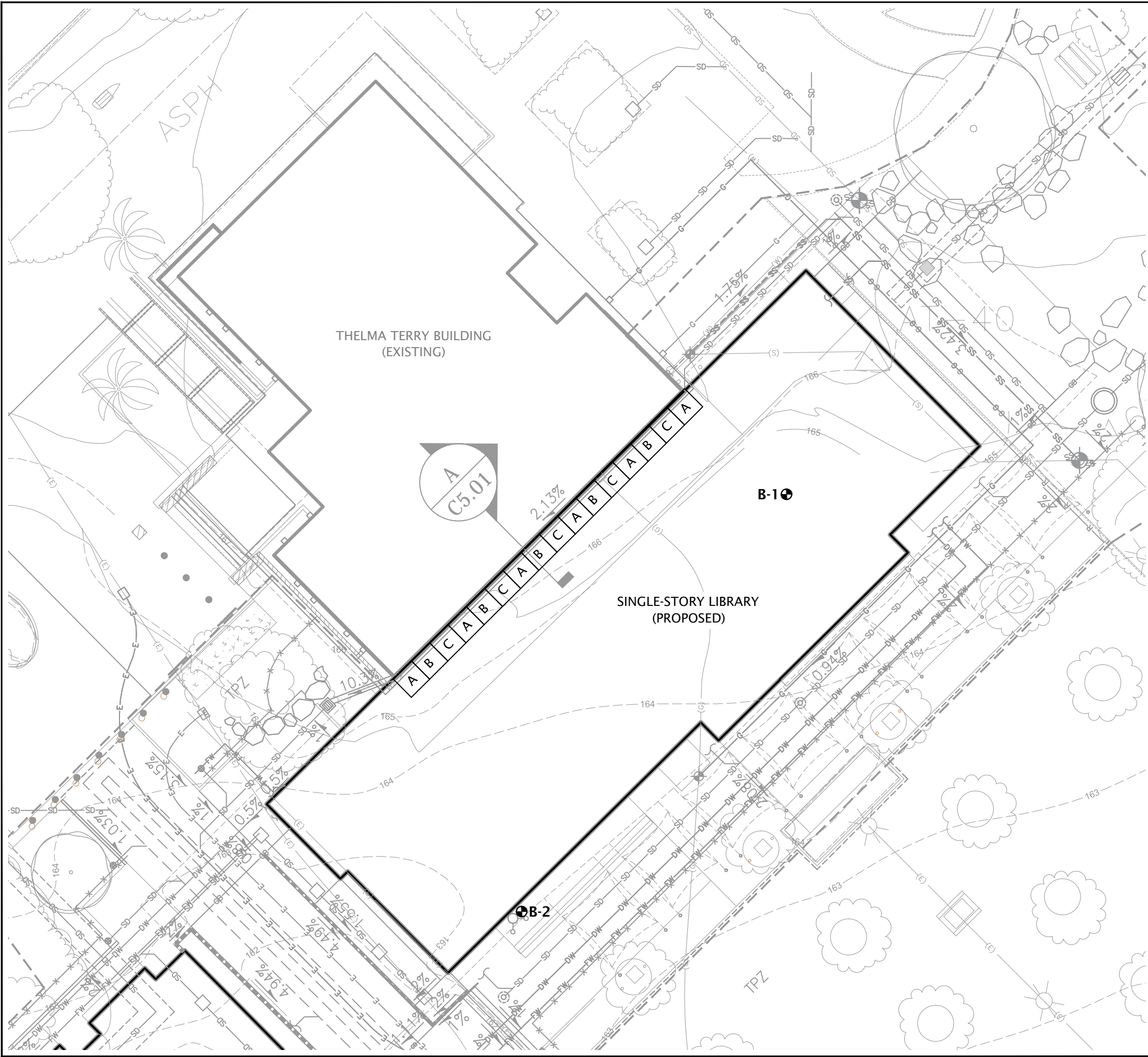
Attachment

Six copies submitted

Document ID: SMonica-10-01-102711-geoa-1.doc

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## FIGURES



LEGEND:

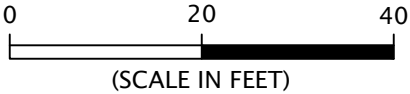
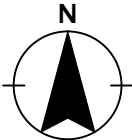
B-1

BORING  
(SMONICA-10-01)  
SLOT-CUT SECTIONS

A	B	C	A
---	---	---	---

CONSTRUCTION SEQUENCE NOTES:

1. EXCAVATE SLOT A SECTIONS.
2. CONSTRUCT FOUNDATION IN SLOT A SECTIONS.
3. EXCAVATE SLOT B SECTIONS.
4. CONSTRUCT FOUNDATION IN SLOT B SECTIONS.
5. EXCAVATE SLOT C SECTIONS.
6. CONSTRUCT FOUNDATION IN SLOT C SECTIONS.



SITE PLAN BASED ON DRAWING PROVIDED BY  
CITY OF SANTA MONICA ARCHITECTURAL SERVICES  
OCTOBER 19, 2011

**GEO**DESIGN

2121 S Towne Centre Place - Suite 130  
Anaheim CA 92806  
Off 714.634.3701 Fax 714.634.3711

SMONICA-10-01

OCTOBER 2011

SITE PLAN

PROPOSED PICO BRANCH LIBRARY  
SANTA MONICA, CA

FIGURE 1

To:	Tom Afschar, AIA, CASp	From:	Chris Zadoorian
Company:	City of Santa Monica Architecture Services	Date:	May 8, 2012
Address:	1437 4 <sup>th</sup> Street, Suite 300 Santa Monica, CA 90401		
cc:	n/a		
GDI Project:	SMonica-10-01		
RE:	Proposed Santa Monica Pico Branch Library		

Original File Name	Date	Document Title
SMonica-10-01-100810-geor.doc	10/8/10	Report of Geotechnical Engineering Services; Proposed Santa Monica Pico Branch Library; Virginia Avenue Park; Santa Monica, California; Special Provisions Number 2119

Addendum Number	Date	Description
1	10/27/11	Geotechnical Recommendations for Temporary Excavations
2	5/8/12	Response to Geotechnical Comments, City of Santa Monica Review Sheet (attached)

kt

Attachments

Six copies submitted

Document ID: SMonica-10-01-050812-geocat-2.doc

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May 8, 2012

City of Santa Monica  
Architecture Services  
1437 4<sup>th</sup> Street, Suite 300  
Santa Monica, CA 90401

Attention: Mr. Tom Afschar, AIA. CASp

**Addendum 2**  
**Response to Geotechnical Comments**  
**City of Santa Monica Review Sheet**  
Proposed Santa Monica Pico Branch Library  
Virginia Avenue Park  
Santa Monica, California  
**Building & Safety # 12PC0040**  
**GeoDesign Project: SMonica-10-01**

## **INTRODUCTION**

We performed a geotechnical investigation for the proposed Santa Monica Pico Branch Library to be constructed within Virginia Avenue Park located at the northwest corner of Pico Boulevard and Cloverfield Boulevard in Santa Monica, California. The results of our investigation were submitted in a report dated October 8, 2010 and in an addendum dated October 27, 2011.

LOR Geotechnical Group, Inc. (LOR), acting as a review consultant for the City of Santa Monica, issued comments to our report in a Geotechnical Review Sheet dated February 16, 2012 (LOR Project No. 62739.246).

LOR's comments are presented below followed by our responses.

## **LOR REVIEW COMMENT 1**

*A tabulation of recorded peak ground accelerations from nearby recording stations for major events affecting Santa Monica shall be summarized in tabular form. This tabulation shall include the identification of the recording station, peak ground acceleration, event, date of event, epicenter distances, magnitudes, and distance between recording stations and the site. A map showing the locations of the stations and the site shall also be included (Section 3.3 of the Guidelines for Geotechnical Reports, City of Santa Monica, dated March 2010).*



## GEODESIGN, INC. RESPONSE TO LOR REVIEW COMMENT 1

As indicated in Section 3.3 of the *Guidelines for Geotechnical Reports, City of Santa Monica (March 2010)*, only the Northridge event needs to be considered. The Northridge earthquake was a magnitude 6.7 earthquake that occurred in Northridge, California, on January 17, 1994.

Recorded peak ground accelerations from recording stations within a 5-mile radius for the Northridge earthquake are summarized in Table 1. Table 1 includes the identification of the recording station, peak ground acceleration, epicenter distances, and distance between recording stations and the site.

A map that shows the location of the recording stations is included as Figure A-1 (Attachment A).

**Table 1. Strong Motion Recordings for the Northridge Earthquake**

<b>Recording Station Number</b>	<b>Location of Station</b>	<b>Peak Acceleration</b>	<b>Distance from Epicenter (miles)</b>	<b>Distance Between Site and Recording Station (miles)</b>
47	8505 Saran Drive, Plaza Del Rey	0.144	18.4	4.7
54	3960 Centinela Street, Los Angeles	0.447	15.8	2.4
638	Los Angeles-Brentwood VA	0.188	11.1	2.7
663	10751 Wilshire Boulevard	0.393	11.9	3
5082	Wadsworth VA Hospital	0.389	12	2.2
5263	10660 Wilshire Boulevard	1.055	12	3.1
5277	12121 Wilshire Boulevard	0.325	12.3	1.5
5284	Lowe Residence	0.525	13	1.7
5292	Los Angeles 2121 Avenue of the Stars	0.411	12.9	3.7
5456	10920 Wilshire Boulevard	0.249	11.9	2.7
24231	Los Angeles 7-story UCLA Math/Science Building	0.29	11.3	3.4
24332	Los Angeles 3-story commercial building	0.33	12.5	3.5
24389	Century City - LACC North	0.27	12.5	3.9

**Table 1. Strong Motion Recordings for the Northridge Earthquake (continued)**

<b>Recording Station Number</b>	<b>Location of Station</b>	<b>Peak Acceleration</b>	<b>Distance from Epicenter (miles)</b>	<b>Distance Between Site and Recording Station (miles)</b>
24390	Century City – LACC South	0.35	12.5	3.9
24538	City Hall Grounds	0.93	14.4	1.7
24643	Los Angeles 19-story office building	0.32	12.5	3.6
24670	I10/405 interchange bridge	1.830 (structure)	13.8	1.8
24688	UCLA Grounds	0.66	11.3	3.4

**LOR REVIEW COMMENT 2**

*The boring logs should identify the native soil contact.*

**GEODESIGN, INC. RESPONSE TO LOR REVIEW COMMENT 2**

We have revised the boring logs to clearly identify the contact between the fill materials and native soils. The logs are included in Attachment B.

**LOR REVIEW COMMENT 3**

*The report should evaluate the temporary stability during grading, foundation construction, and retaining wall excavations as outline in Section 3.8.8 of the current city guidelines (March 2010).*

**GEODESIGN, INC. RESPONSE TO LOR REVIEW COMMENT 3**

**GENERAL**

In a letter dated October 27, 2011, we provided recommendations for slot-cutting to allow the required temporary excavations adjacent to the existing Thelma Terry Community Center building. However, at that time, it was our understanding, based on conceptual sketches you provided, that the new library footings would be a maximum depth of approximately 2 feet below the bottom of the adjacent community center building footings.

On April 26, 2012 you provided us with an updated sketch that indicates the new library footings will extend a maximum depth of approximately 5.5 feet below the bottom of the Thelma Terry Community Center building foundation. Figures A-2 and A-3 depict the current proposed conditions.

The on-site soils consist of silty sand and will stand vertically for this depth when considering the loading applied from the Thelma Terry Community Center building and temporary shoring will be required to construct the necessary excavation.

Temporary shoring may consist of soldier piles and timber lagging and should be designed to limit the lateral deflection to ¼ inch or less at the top of the shoring.

Soldier piles may be installed in a manner so that they can also serve to underpin the existing Thelma Terry Community Center building foundation or the shoring may be designed to resist surcharge loading from the existing foundation.

Groundwater is not anticipated to impact the shoring installation.

#### **DESIGN LATERAL EARTH PRESSURES**

Cantilevered shoring should be designed to resist a triangular lateral earth pressure distribution, where the maximum value is 30H pounds per square foot (psf). For cantilevered shoring design, where the surface at the top of the shoring is sloped, the recommended lateral earth pressures should be increased as indicated in Table 2.

**Table 2. Temporary Shoring – Lateral Earth Pressures**

<b>Slope Inclination at Top of Shoring (horizontal to vertical)</b>	<b>Increase in Lateral Earth Pressure (percent)</b>
1:1	200
1.5:1	165
2:1	150

If soldier piles are not designed to provide vertical support for the existing Thelma Terry Community Center building, the lower approximately 4 feet of the new below-grade library wall should be designed to resist an additional pressure of 1,500 psf resulting from the existing foundation.

#### **SOLDER PILES, TEMPORARY AND PERMANENT SUPPORT OF EXISTING FOUNDATION**

For the design of soldier piles spaced at least 2 diameters on centers, the allowable lateral bearing value (passive value) of the native soils below the level of excavation may be assumed to be 300 psf per foot of depth, up to a maximum of 6,000 psf. The recommended value may be doubled for the case of isolated piles as allowed per the current city guidelines (March 2010).

If the embedded portion of the soldier pile shaft is filled with lean-mix concrete with a minimum compressive strength of 2,000 pounds per square inch, then the effective width of the soldier pile shaft for use in developing passive resistance may be assumed to be twice the diameter of the shaft. If the embedded portion of the soldier pile shaft is filled with other materials (such as low strength sand-cement slurry), the effective width of the soldier pile should be limited to be the diagonal dimension of the soldier pile beam.

Solider piles a minimum of 30 inches in diameter and extending 20 feet below the bottom of the excavation may be designed to resist axial loading assuming 4 kips per foot of embedment below the bottom of the excavation.

Caving may be encountered during the drilling of the solider piles. The shoring contractor should provide mitigation measures for caving that may include the use of drilling fluid and/or steel casing.

#### ***TIMBER LAGGING***

Continuous lagging will be required between the soldier piles. The soldier piles should be designed for the full anticipated lateral pressure; however, the pressure on the lagging will be less due to arching in the soils. For clear spans of up to 6 feet, we recommend that the lagging be designed for a triangular distribution of earth pressure where the maximum pressure is 400 psf at the mid-line between soldier piles and 0 psf at the soldier piles.

If the solider piles are not designed as permanent elements, a uniform surcharge pressure equal to 1,500 psf should be applied to shoring to account for the surcharge loading from the adjacent foundation.

#### ***LIBRARY PARTIAL BELOW-GRADE WALL***

If the solider piles are not designed as permanent elements, a uniform surcharge pressure equal to 1,500 psf should be applied to the permanent below-grade wall below the bottom of the Thelma Terry Community Center foundation level.

#### ***DOCUMENTATION OF EXISTING CONDITIONS AND MONITORING OF SHORING SYSTEM***

It would be prudent to perform an existing condition survey for the existing Thelma Terry Community Center building prior to construction, including mapping and photographing of existing cracks and other prominent conditions.

Monitoring of the existing building and the deflection of the shoring system should be on-going during construction until such time that the new foundations, slab on grade, and partial below-grade wall are complete.

◆ ◆ ◆

It is our pleasure to provide continued geotechnical consultation services for the proposed Santa Monica Pico Branch Library. Please contact us with any questions or comments regarding this addendum.

Sincerely,

GeoDesign, Inc.

*Viola C. Lai w/ permission MLB*

Viola C. Lai  
Project Engineer



Christopher J. Zadoorian, G.E.  
Principal Engineer



VCL:CJZ:kt

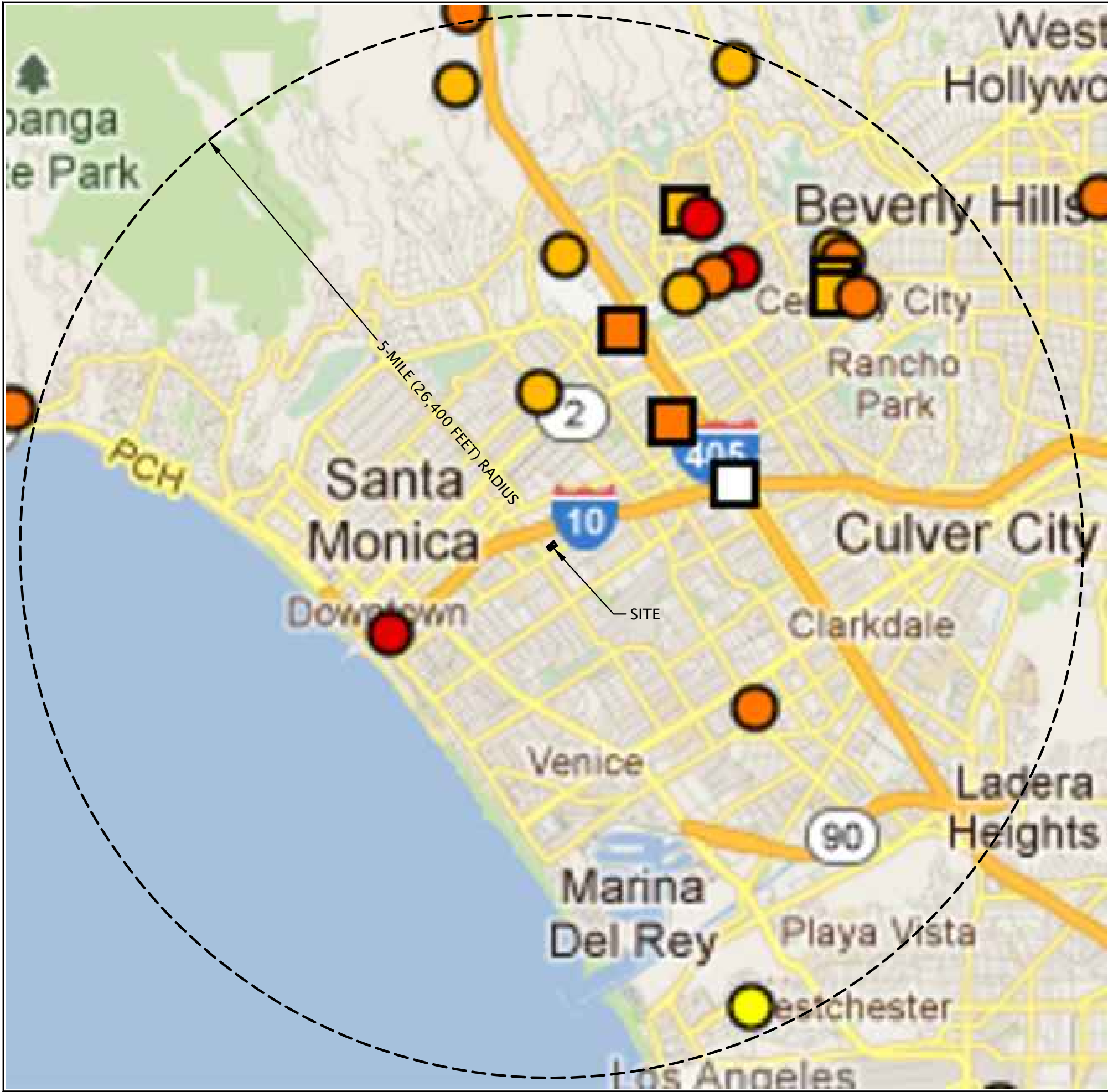
Attachments

Six copies submitted

Document ID: SMonica-10-01-050812-geoa-2.doc

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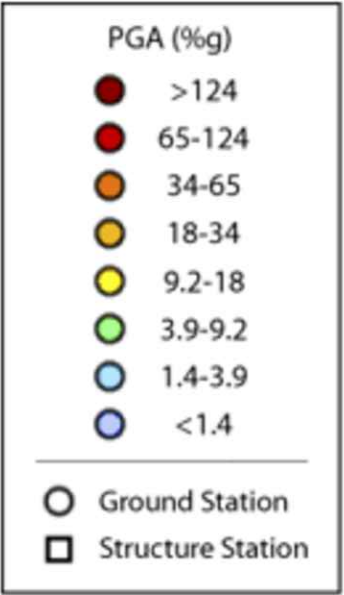
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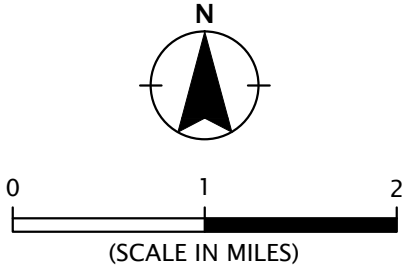
LEGEND:

◆ SITE

----- 5-MILE (26,400 FEET) RADIUS

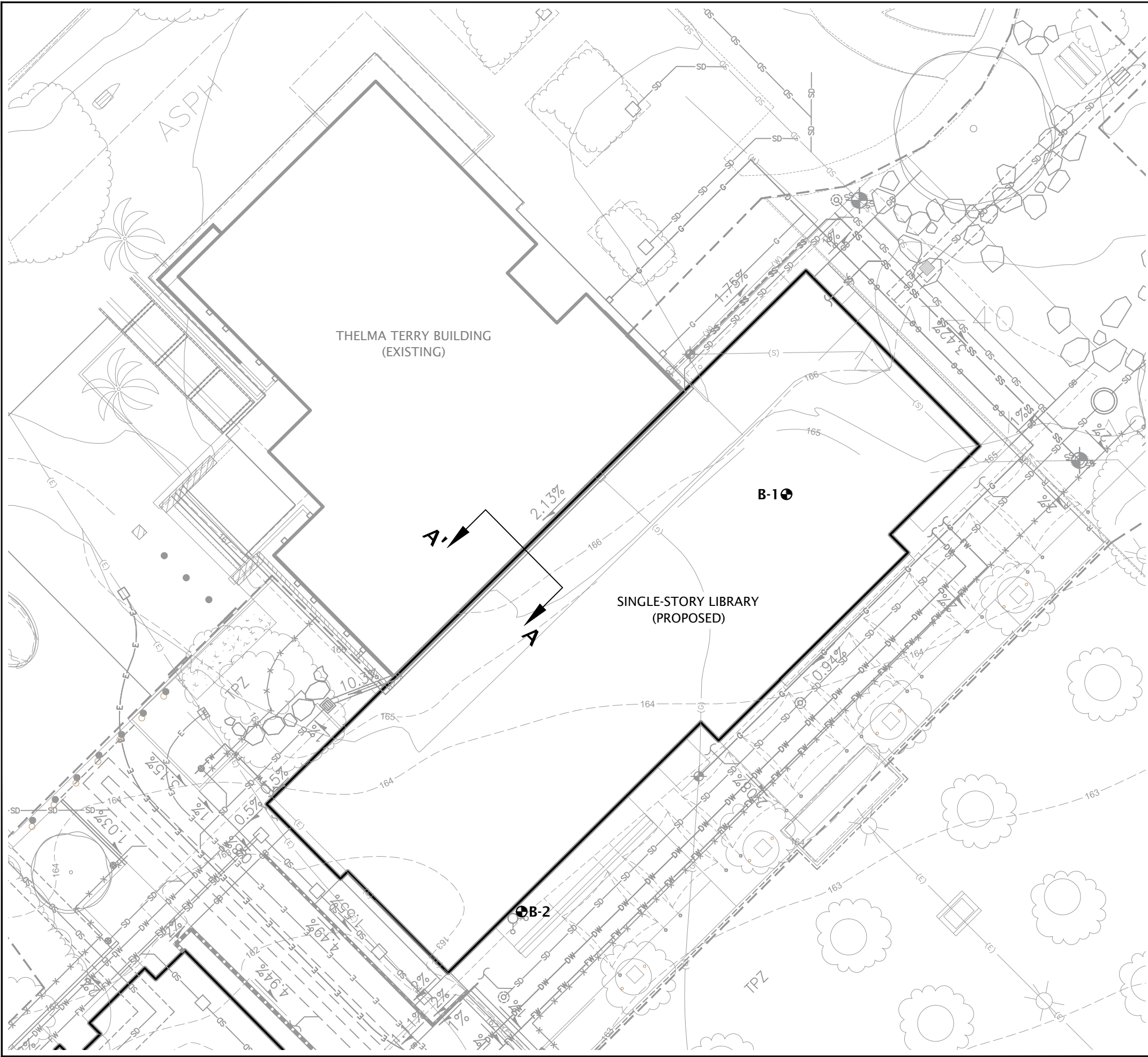


Note: Station locations are approximate when viewed at high zoom levels.





SITE PLAN BASED ON IMAGE OBTAINED FROM  
CENTER FOR ENGINEERING STRONG MOTION DATA  
APRIL 18, 2012

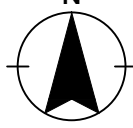
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**LEGEND:**

B-1  BORING


A  A' TYPICAL CROSS SECTION



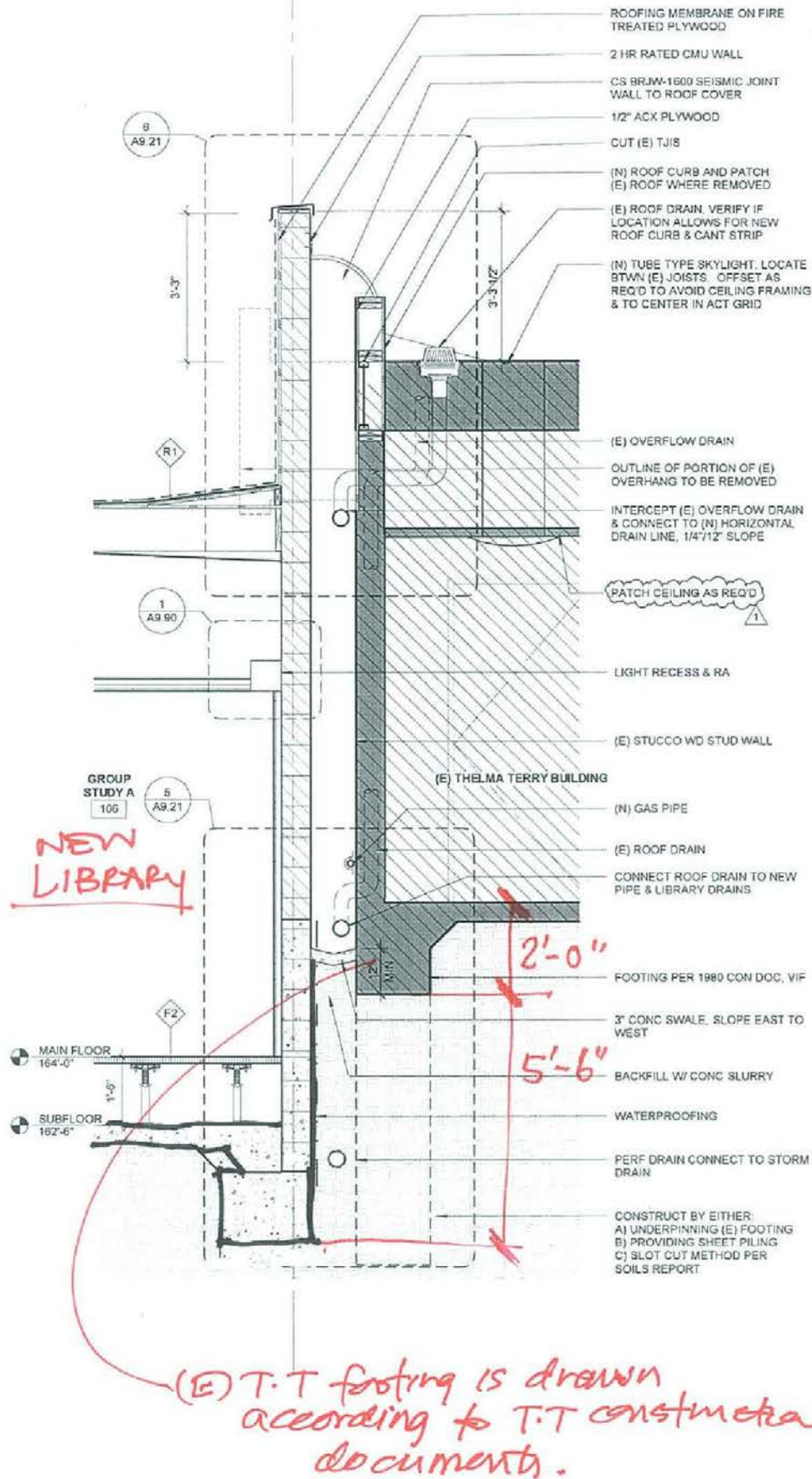
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(SCALE IN FEET)

SITE PLAN BASED ON DRAWING PROVIDED BY  
CITY OF SANTA MONICA ARCHITECTURAL SERVICES  
OCTOBER 19, 2011

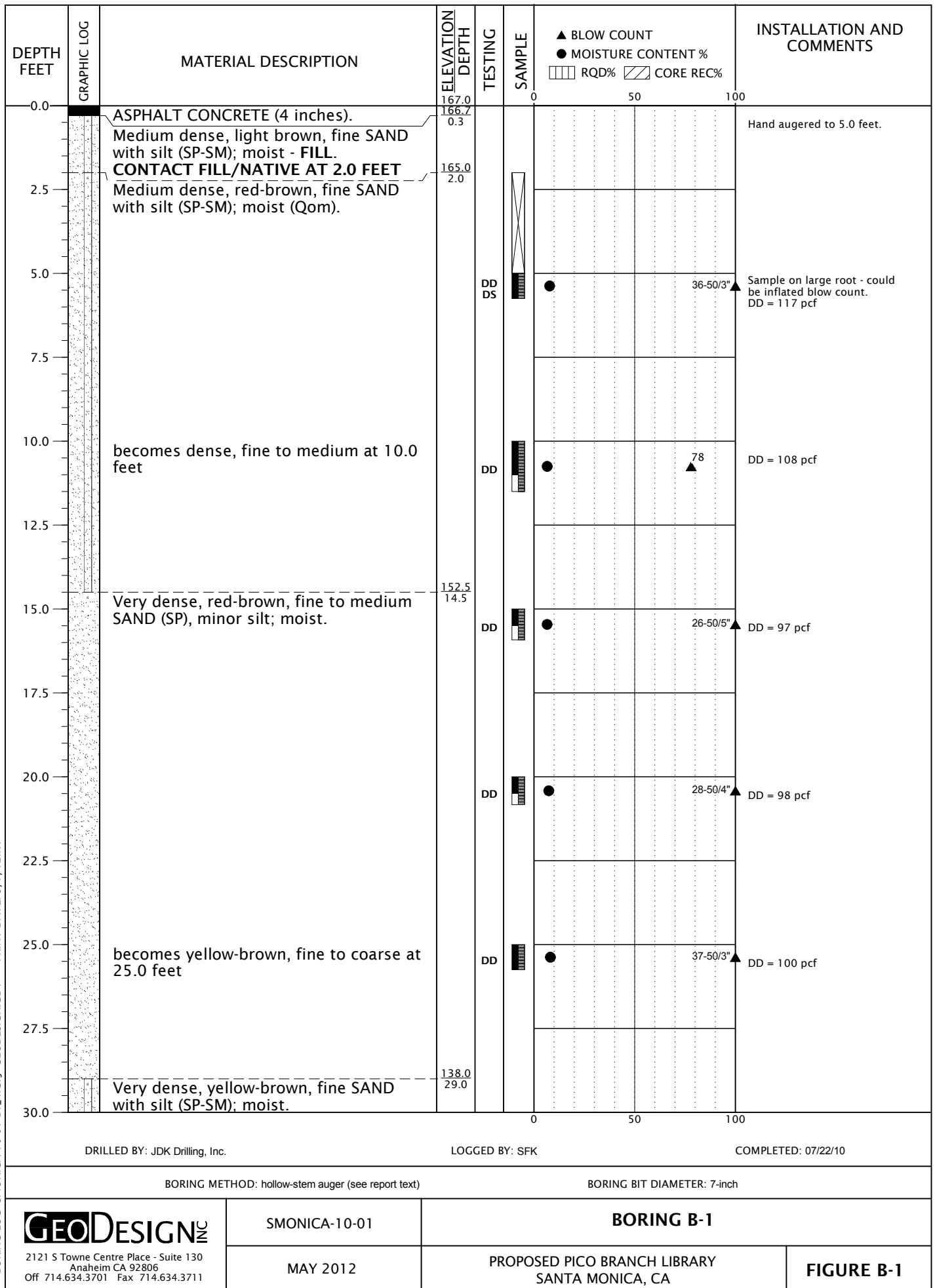
 2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711	SMONICA-10-01	SITE PLAN	FIGURE A-2
	MAY 2012	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA	





**ATTACHMENT B**

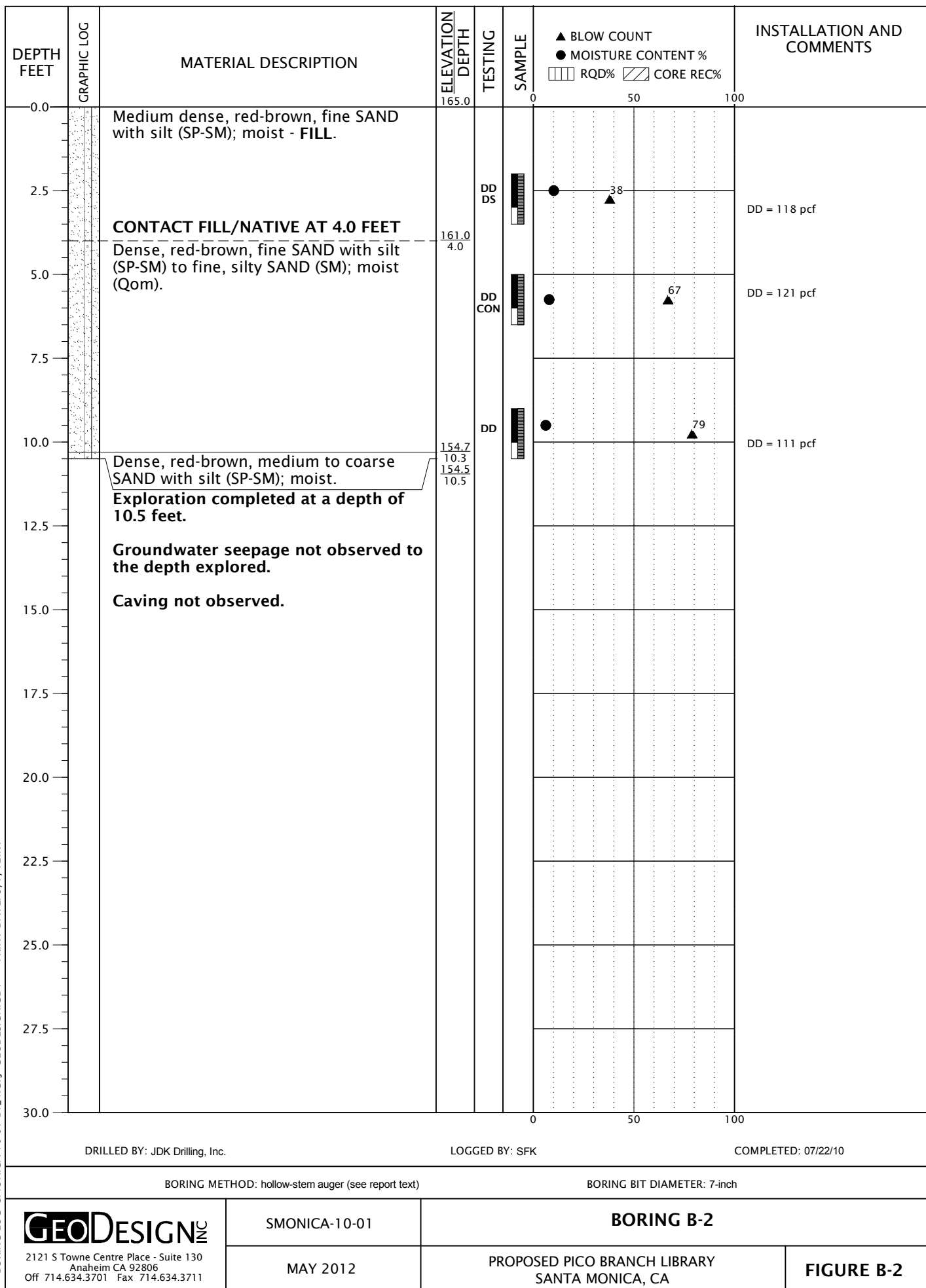
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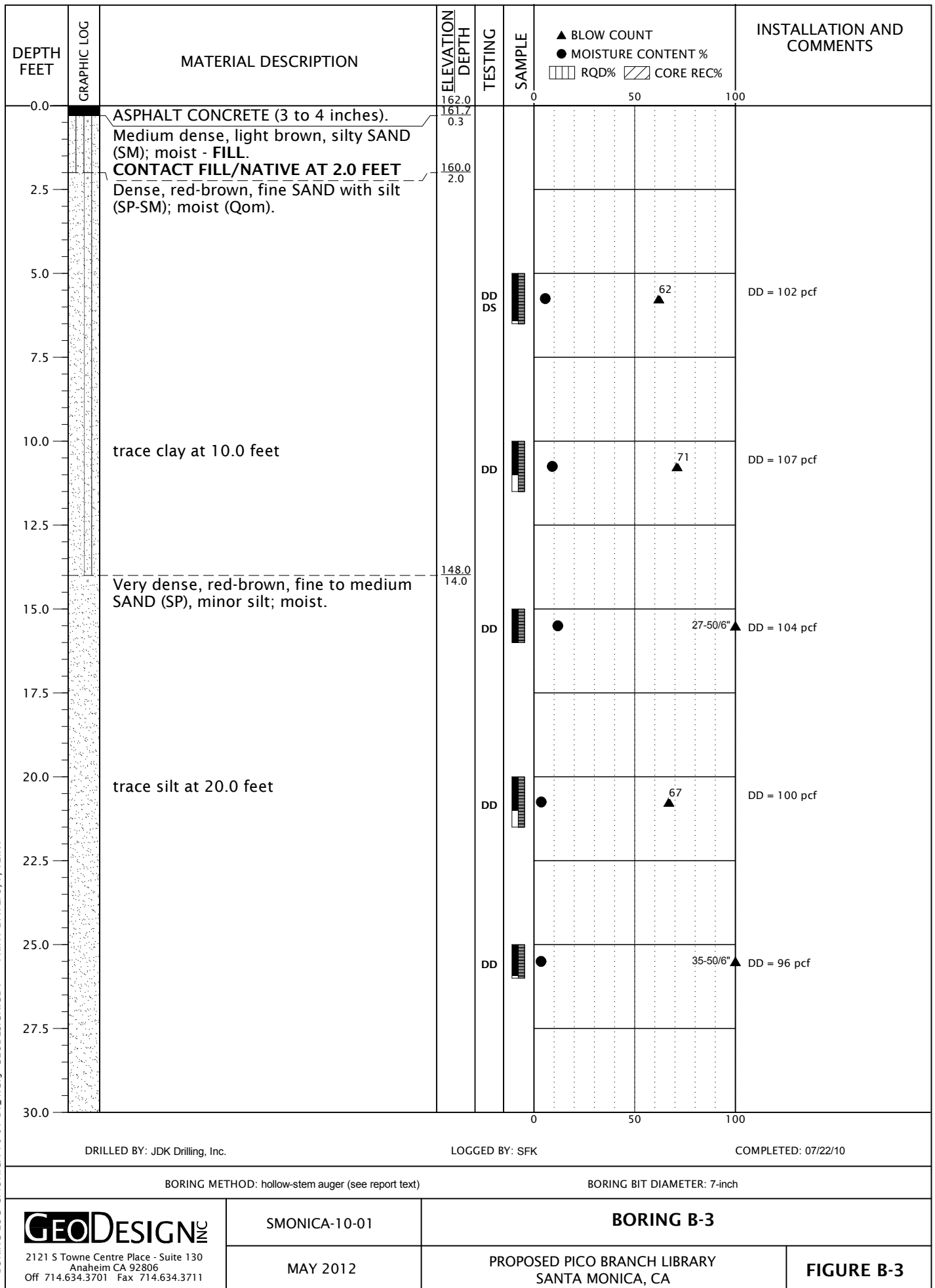


BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 5/7/12:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
30.0		(continued from previous page)		DD		0 50 100	DD = 88 pcf
32.5							
35.0				DD		0 50 100	DD = 88 pcf
37.5		Exploration completed at a depth of 36.5 feet.	130.5 36.5				
40.0		Groundwater seepage not observed to the depth explored.					
42.5		Caving not observed.					
45.0							
47.5							
50.0							
52.5							
55.0							
57.5							
60.0						0 50 100	
DRILLED BY: JDK Drilling, Inc.			LOGGED BY: SFK			COMPLETED: 07/22/10	
BORING METHOD: hollow-stem auger (see report text)					BORING BIT DIAMETER: 7-inch		
<div>GeoDesign</div> <div>2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711</div>		SMONICA-10-01	BORING B-1 (continued)				
		MAY 2012	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA			FIGURE B-1	

BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 5/7/12:KT





BORING LOG SMONICA-10-01-B1\_4.GPJ GEODESIGN.GDT PRINT DATE: 5/7/12:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
30.0		minor silt at 30.0 feet				0 50 100	
32.5							
35.0							
37.5		Exploration completed at a depth of 36.5 feet.	125.5 36.5				
40.0		Groundwater seepage not observed to the depth explored.					
42.5		Caving not observed.					
45.0							
47.5							
50.0							
52.5							
55.0							
57.5							
60.0						0 50 100	
DRILLED BY: JDK Drilling, Inc.		LOGGED BY: SFK		COMPLETED: 07/22/10			
BORING METHOD: hollow-stem auger (see report text)					BORING BIT DIAMETER: 7-inch		
<div>GEODESIGN</div> <div>2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711</div>		SMONICA-10-01	BORING B-3 (continued)				
		MAY 2012	PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA				FIGURE B-3

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
0.0		LAWN (driving turf with reinforcing grid, 3 inches).	168.0		0		
		Medium dense, light-brown, silty SAND (SM); moist - FILL.	167.7 0.3				
		CONTACT FILL/NATIVE AT 1.0 FOOT	167.0 1.0				
2.5		Dense, brown, fine to medium SAND with silt (SP-SM); moist (Qom).					
							28-50/4"
5.0		Dense, red-brown, fine SAND (SP), minor silt; moist.	163.5 4.5				
							56
7.5							
10.0		becomes very dense, fine to medium at 10.0 feet					
							45-50/6"
12.5		Exploration completed at a depth of 11.5 feet.	156.5 11.5				
		Groundwater seepage not observed to the depth explored.					
15.0		Caving not observed.					
17.5							
20.0							
22.5							
25.0							
27.5							
30.0							
DRILLED BY: JDK Drilling, Inc.		LOGGED BY: SFK		COMPLETED: 07/22/10			
BORING METHOD: hand-auger (see report text)				BORING BIT DIAMETER: 7-inch			
GEO DESIGN		SMONICA-10-01		BORING B-4			
2121 S Towne Centre Place - Suite 130 Anaheim CA 92806 Off 714.634.3701 Fax 714.634.3711		MAY 2012		PROPOSED PICO BRANCH LIBRARY SANTA MONICA, CA		FIGURE B-4	



## APPENDIX B: LEED SCORECARD

## LEED NC 2009 Scorecard

Pico Branch Library

6/22/2012



Yes	?Y	?N	No
87	3	7	13

Certified 40-49 Silver 50-59 Gold 60-79 Platinum 80+

BRIGHTWORKS™

## Total Project Score

Y	?Y	?N	N					Y	?Y	?N	N				
23	1	0	2	Sustainable Sites				6	1	0	7	Materials & Resources			
Y				C	Prereq 1	Construction Activity Pollution Prevention	n/a	Y				d	Prereq 1	Storage & Collection of Recyclables	n/a
1				d	Credit 1	Site Selection	1				3	d	Credit 1.1	Building Reuse, Maintain Existing Walls, Floors & Roof	1-3
5				d	Credit 2	Development Density & Community Connectivity	5				1	d	Credit 1.2	Building Reuse, Maintain 50% of Interior Non-Structural Elements	1
			1	d	Credit 3	Brownfield Redevelopment	1	1				C	Credit 2.1	Construction Waste Management, Divert 50%	1
6				d	Credit 4.1	Alternative Transportation, Public Transportation Access	6	1				C	Credit 2.2	Construction Waste Management, Divert 75%	1
1				d	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1				1	d	Credit 3.1	Materials Reuse, Specify 5%	1
3				d	Credit 4.3	Alternative Transportation, Low Emitting & Fuel Efficient Vehicles	3				1	d	Credit 3.2	Materials Reuse, Specify 10%	1
2				d	Credit 4.4	Alternative Transportation, Parking Capacity	2	1				C	Credit 4.1	Recycled Content, 10%	1
			1	C	Credit 5.1	Site Development, Protect or Restore Habitat	1	1				C	Credit 4.2	Recycled Content, 20%	1
1				d	Credit 5.2	Site Development, Maximize Open Space	1	1				C	Credit 5.1	Regional Materials, 10%	1
1				d	Credit 6.1	Stormwater Design, Quantity Control	1		1			C	Credit 5.2	Regional Materials, 20%	1
1				d	Credit 6.2	Stormwater Design, Quality Control	1				1	C	Credit 6	Rapidly Renewable Materials 2.5%	1
1				C	Credit 7.1	Heat Island Effect, Non-Roof	1	1				C	Credit 7	Certified Wood	1
1				d	Credit 7.2	Heat Island Effect, Roof	1								
	1			d	Credit 8	Light Pollution Reduction	1								
8	0	0	2	Water Efficiency				12	1	0	2	Indoor Environmental Quality			
Y				d	Prereq 1	Water Use Reduction, 20% Reduction	n/a	Y				d	Prereq 1	Minimum IAQ Performance	n/a
2			2	d	Credit 1	Water Efficient Landscaping, Reduce by 50% , No Potable Use	2-4				1	d	Prereq 2	Environmental Tobacco Smoke (ETS) Control	n/a
2				d	Credit 2	Innovative Wastewater Technologies	2	1				d	Credit 1	Outdoor Air Delivery Monitoring	1
4				d	Credit 3	Water Use Reduction, 30%, 35%, 40% reduction	2-4	1				C	Credit 2	Increased Ventilation	1
								1				C	Credit 3.1	Construction IAQ Management Plan, During Construction	1
								1				C	Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
								1				C	Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
								1				C	Credit 4.2	Low-Emitting Materials, Paints & Coatings	1
								1				C	Credit 4.3	Low-Emitting Materials, Flooring Systems	1
								1				C	Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1
								1				d	Credit 5	Indoor Chemical & Pollutant Source Control	1
15		4		d	Credit 1	Optimize Energy Performance, 12% to 48%	1-19				1	d	Credit 6.1	Controllability of Systems, Lighting	1
4		3		d	Credit 2	On-Site Renewable Energy, 1% to 13%	1-7	1				d	Credit 6.2	Controllability of Systems, Thermal Comfort	1
2				C	Credit 3	Enhanced Commissioning	2	1				d	Credit 7.1	Thermal Comfort, Design	1
2				d	Credit 4	Enhanced Refrigerant Management	2	1				d	Credit 7.2	Thermal Comfort, Verification	1
3				C	Credit 5	Measurement & Verification	3		1			d	Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
2				C	Credit 6	Green Power 35%	2	1				d	Credit 8.2	Daylight & Views, Views for 90% of Spaces	1
6	0	0	0	Innovation & Design Process				4	0	0	0	Regional Credits			
1				C	Credit 1.1	Innovation in Design: Ed Building for Community	1					90404 ← Project Zip Code			
1				C	Credit 1.2	Innovation in Design: Green O+M per City of SM	1	1				d	Credit 1.1	Regional Credit: SSsc5.2	1
1				d	Credit 1.3	Innovation in Design: Exemplary Performance SSsc5.2 (40%)	1	1				d	Credit 1.2	Regional Credit: WEc2	1
1				C	Credit 1.4	Innovation in Design: Exemplary Performance EAc6	1	1				d	Credit 1.3	Regional Credit: WEc3 (40%)	1
1				C	Credit 1.5	Innovation in Design: Exemplary Performance MRc2 (95%)	1	1				d	Credit 1.4	Regional Credit: EAc2 (1%)	1
1				Alternative	Innovation in Design: Exemplary Performance WEc3 (45%)						1	d	Credit 1.5	Regional Credit: MRc1.1 (55%)	1
1				C	Credit 2	LEED™ Accredited Professional	1		1			d	Credit 1.6	Regional Credit: IEQc8.1	1

## APPENDIX C: AUTOMATED BOOK SORTER SYSTEM

# 3M™ Intelligent Return and Sorter System FX

## Architect/Contractor's Package



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3M™ Intelligent Return and Sorter System FX Architect/Contractor's Package 78-8129-3966-4A8

3M is a trademark of 3M.

**The original instructions in this document were written in U.S. English. All other languages are a translation of the original instructions.**

# Contents

<b>Introduction</b>	<b>1</b>
Using this architect/contractor package	1
Introducing the 3M™ Intelligent Return and Sorter System FX	1
System modules	2
3M™ Intelligent Return Classic and 3M Intelligent Return Plus	2
3M™ Intelligent Return Staff Model 2830	3
FX Sorter Model 2850	3
FX System Controller Model 2855	4
FX Directional Conveyor Model 2860	4
FX Ramp Conveyor Model 2861	5
FX Lift-Gate Conveyor Model 2862	5
FX Two-foot Conveyor Model 2863	6
FX Four-foot Conveyor Model 2864	6
Bin Model 2899	7
Implementation responsibilities	8
<b>Construction requirements</b>	<b>9</b>
Electrical requirements	9
Environmental requirements	11
Network requirements	11
Module weights	12
Module dimensions	13
Intelligent Return Classic and Plus (Models 2810, 2812, 2820 and 2822)	13
Intelligent Return Staff Model 2830	14
FX Sorter Model 2850	14
FX System Controller Model 2855	15
FX Directional Conveyor Model 2860	15
FX Ramp Conveyor Model 2861	16
FX Lift-Gate Conveyor Model 2862	17
FX Two-Foot Conveyor Model 2863	18
FX Four-Foot Conveyor Model 2864	18
Model 2899	19
Wall construction: Models 2810 and 2812	20
Front elevation	20
Side elevation	21
Wall thickness and weight bearing capacity	21
Wall construction: Models 2820 and 2822	22
Front elevation	22
Side elevation	23
Wall thickness and weight bearing capacity	23
Space requirements and recommendations	24
Minimum distances between RFID systems	24
Minimum access requirements	25
Install the surround	26
Insulate the surround of outdoor units	27
<b>Sample configurations</b>	<b>28</b>
Three bin configuration	28
Three bin configuration with Staff Intelligent Return	28
Five bin configuration	29
Five bin configuration with Staff Intelligent Return	29
Seven bin configuration	30
Seven bin configuration with Staff Intelligent Return	30
Seven bin configuration from two Intelligent Returns	31

## Contents

Eleven bin configuration.....	32
Fifteen bin configuration.....	33
<b>Warranty .....</b>	<b>34</b>
<b>3M Service .....</b>	<b>35</b>
3M Service phone numbers .....	35
3M Library Systems Web Site .....	35

# Introduction

## Using this architect/contractor package

This package provides architects and contractors with information necessary to prepare the site for the installation of the 3M Intelligent Return and Sorter System FX. The information provided here *must* be followed to ensure optimal performance.

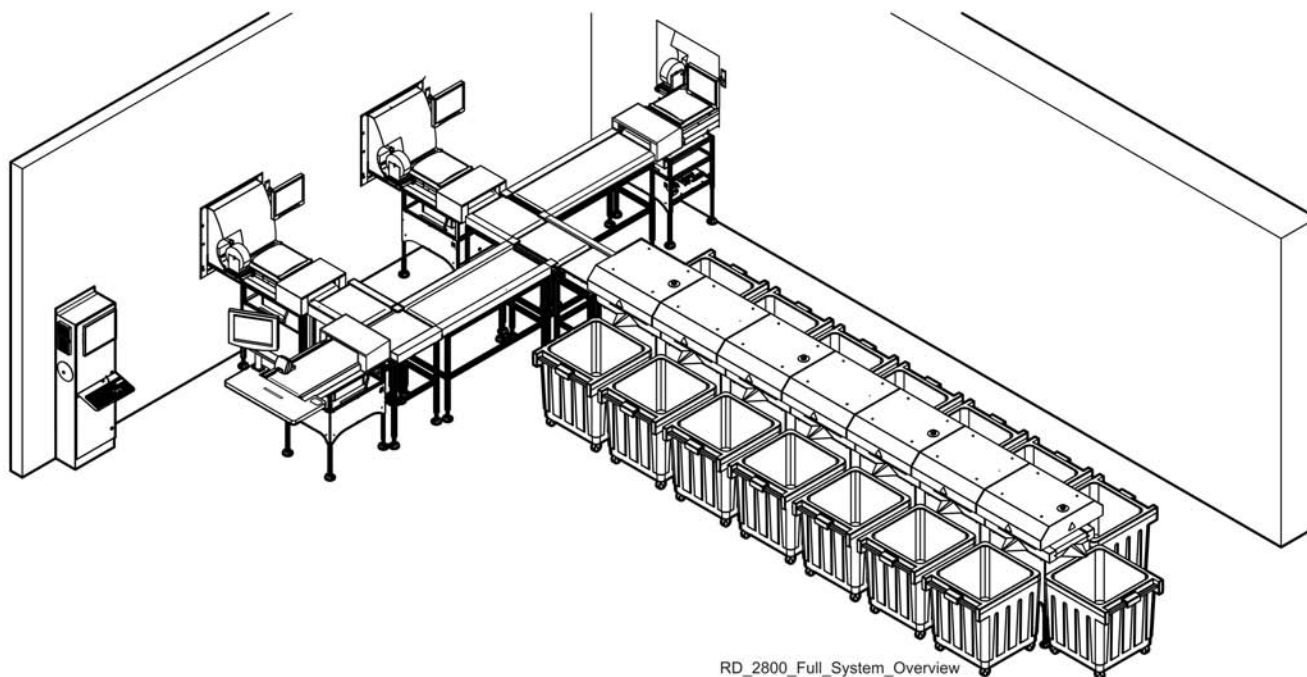
Before beginning new construction or changing an existing structure, contact 3M Library Systems Technical Service at 1-800-328-0067 (website: <http://www.3M.com/library>) or your sales representative to:

- Confirm that you have the most recent version of this document.
- Verify that the proposed system can be installed in the planned space.

## Introducing the 3M™ Intelligent Return and Sorter System FX

The 3M Intelligent Return and Sorter System FX is a complete check-in and sorting system that is both affordable and reliable. It helps libraries increase automated check-in and circulation and maintain a more accurate catalog, while improving productivity and customer service.

### 3M Intelligent Return and Sorter System FX





# System modules

## 3M™ Intelligent Return Classic and 3M Intelligent Return Plus

The 3M Intelligent Return Classic (models 2810 and 2812) and 3M Intelligent Return Plus (models 2820 and 2822) provide the interface between patrons checking in items and the sorting operation. They are installed through the wall that separates patron-accessible areas from a staff area, where sorting occurs. Models 2810 and 2812 provide a simple, intuitive push button interface. Models 2820 and 2822 come with an LCD monitor that can provide patron guidance in several languages, and the monitor on a model 2820 uses touch screen technology to further simplify the check-in operation.

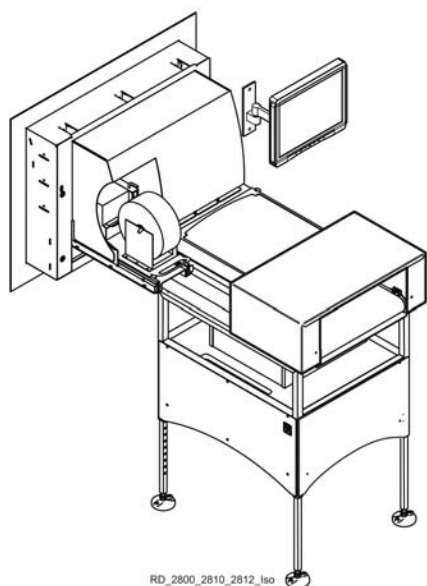
One 3M Intelligent Return or Staff Induction Unit (Model 2830) is required per installation. A maximum of four such devices is supported, which can include any combination of 3M Intelligent Return Units and Staff Induction Units.

The following table lists differences between 3M Intelligent Return models.

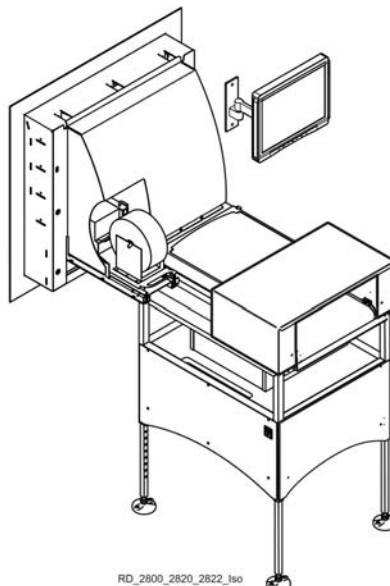
Summary Intelligent Return feature comparison

Model	Installation Type	User Interface	Monitor Type	Item-return door	Item-return shelf type
2810	Interior wall	Two button	None	None / open	Extends from wall
2812	Exterior wall	Two button	None	Automated	Flush with wall
2820	Interior wall	Graphical	Touch screen LCD monitor	None / open	Extends from wall
2822	Exterior wall	Graphical with Four button	LCD monitor	Automated	Flush with wall

Models 2810 and 2812

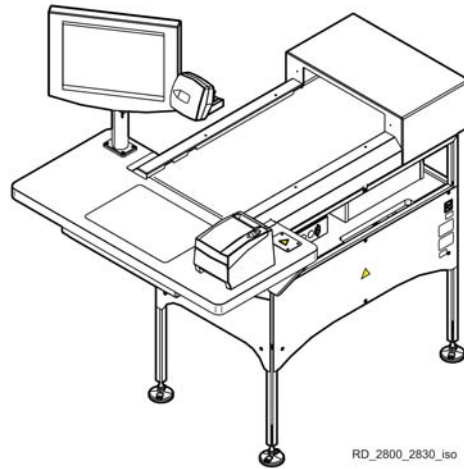


Models 2820 and 2822



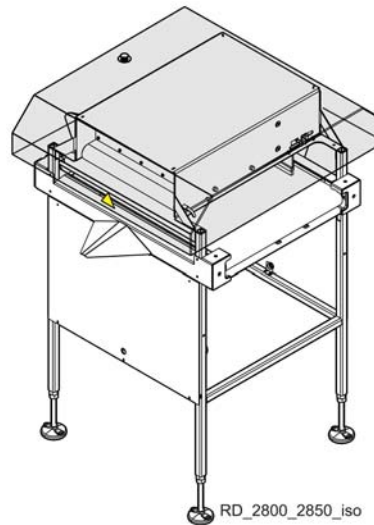
## 3M™ Intelligent Return Staff Model 2830

The Model 2830 enables staff to check in materials from the back office. Up to four induction units of any kind—which also includes 3M Intelligent Return units—is supported in any combination.



## FX Sorter Model 2850

The Model 2850 Sorter selectively either passes items through to another system module or diverts them into bins.



## FX System Controller Model 2855

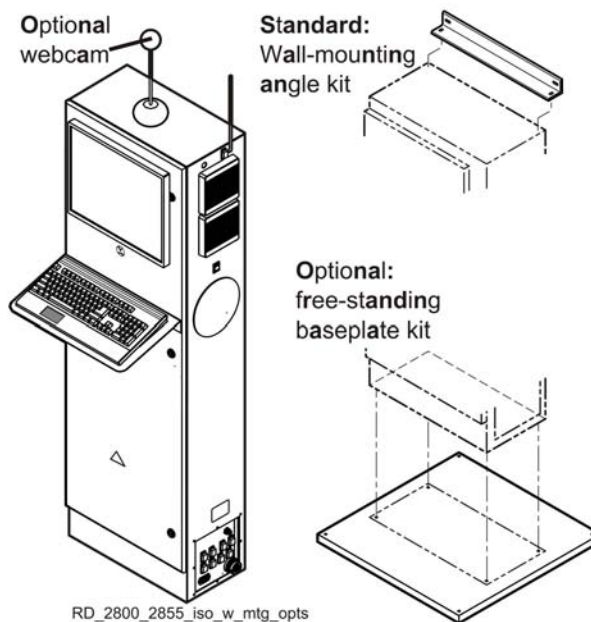
The system controller manages the sorting system.

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**Note:** Typically the system controller will be mounted to a wall of the staff area where the sorter system is installed. An optional baseplate kit for the system controller is available if the unit cannot be mounted to a wall.

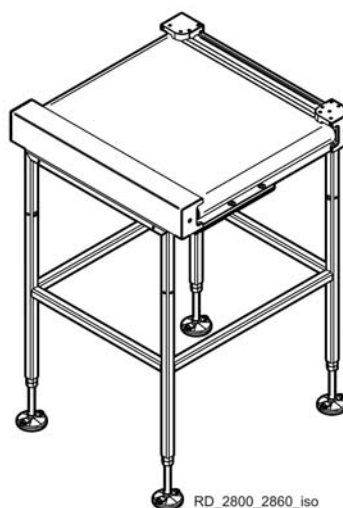
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An optional webcam kit is available for the FX System Controller Model 2855.



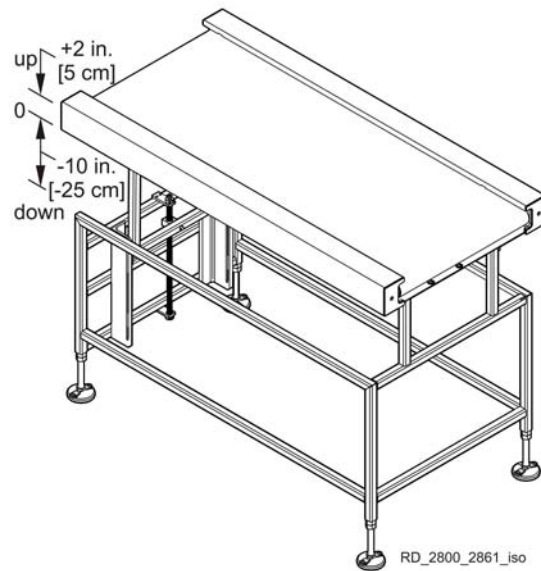
## FX Directional Conveyor Model 2860

The two-foot Model 2860 directional conveyor routes items straight through to the next unit or reroutes them at a right angle, enabling the directional changes required to consolidate returns from multiple 3M Intelligent Returns into a single sortation line.



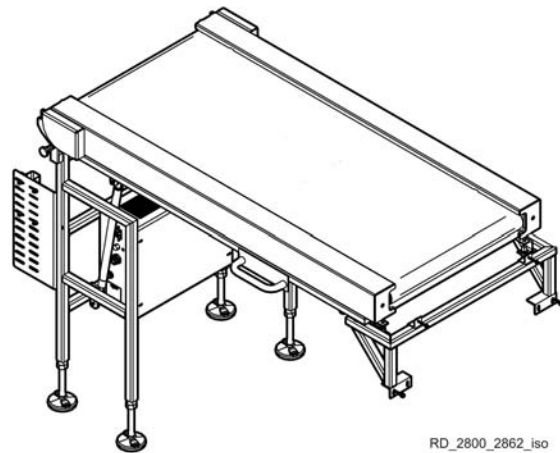
## FX Ramp Conveyor Model 2861

The Model 2861 is a four-foot conveyor that can be tilted up or down. Typically, this unit will be used in configurations where the height of the 3M Intelligent Return has been adjusted to accommodate differences in floor and pavement heights. The height of the intake side of unit can be set from 26 to 38 in. [66 to 97 cm]. The outflow side will always be 36 in. [91 cm].



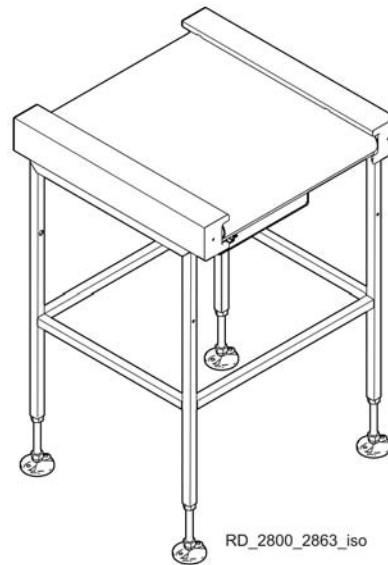
## FX Lift-Gate Conveyor Model 2862

The Model 2862 is a four-foot conveyor that lifts up to provide access to equipment and areas of the room that in some system configurations would be cut off by a conventional conveyor.



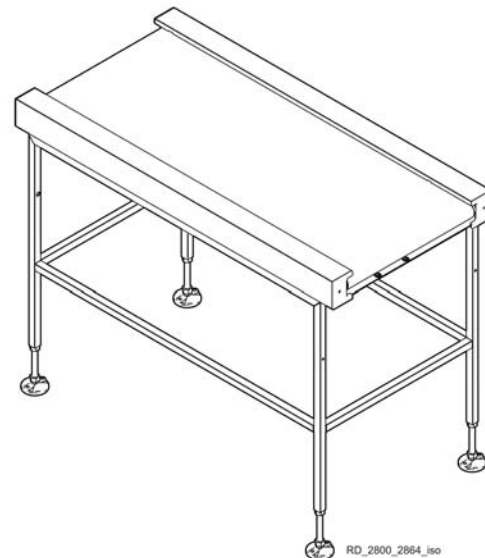
## FX Two-foot Conveyor Model 2863

The Model 2863 is a two-foot conveyor that passes items straight through to the next unit in line.



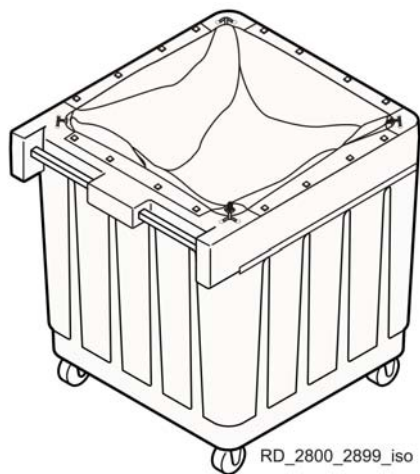
## FX Four-foot Conveyor Model 2864

The Model 2864 is a four-foot conveyor that passes items straight through to the next unit in line.



## Bin Model 2899

The Bin Model 2899 bin is a four-wheel sort bin.



# Implementation responsibilities

This section lists tasks required to install a system, identifies the party responsible for completing each task, and specifies the order of task completion.

1. The library contacts 3M Technical Service (1-800-328-0067 ) (website: <http://www.3M.com/library>) or the 3M sales representative to ensure that it has the most recent version of this document.
2. The library and the 3M sales representative complete a Site Checklist and submit it to 3M.
3. The sales representative provides a System Layout Plan to the library.
4. The library (along with architect/contractor), sales representative, technician, and 3M Technical Service (phone) meet to discuss site preparation details.
5. The library prepares the site for the system, which includes addressing issues identified in the previous step and the following:
  - Installing electrical service according to the requirements listed in [Electrical requirements on page 9](#)
  - Ensuring compliance with the environmental requirements listed in [Environmental requirements on page 11](#)
  - Installing a network connection. See [Network requirements on page 11](#).
  - Providing sufficient space for the system. See [Module dimensions on page 13](#), [Space requirements and recommendations on page 24](#) and [Sample configurations on page 28](#).
  - Preparing a wall for system installation as described in the following sections:
    - [Wall construction: Models 2810 and 2812 on page 20](#)
    - [Wall construction: Models 2820 and 2822 on page 22](#)
  - Installing the surround (U.S.). See [Install the surround on page 26](#).
  - Insulating around the surround of outdoor units. See [Insulate the surround of outdoor units on page 27](#).
6. The 3M sales representative confirms that wall openings for Intelligent Returns are cut and surrounds installed.
7. The 3M technician inspects the site to verify readiness for installation.
8. The 3M technician installs the system.
9. The library completes wall finishing, such as touch-up repair of minor surface damage, drywall taping and sanding, paint or wallpaper, baseboard, etc., *after system installation is complete*.

# Construction requirements

## Electrical requirements

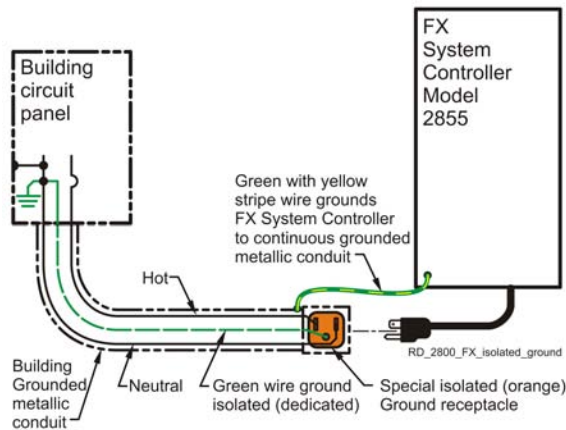
The structure that houses the 3M Intelligent Return and Sorter System must meet the following electrical requirements.

Component	Specification
<ul style="list-style-type: none"><li>Intelligent Return Classic Model 2810</li><li>Intelligent Return Classic Model 2812</li><li>Intelligent Return Plus Model 2820</li><li>Intelligent Return Plus Model 2822</li><li>Intelligent Return Staff Model 2830</li></ul>	<p>These models require the following:</p> <ul style="list-style-type: none"><li>Noise-free and reliable power that conforms to the specifications below.</li><li>A single AC power outlet located in the same room as the staff side (not the outside or side accessible to the public) of the Intelligent Return and within 6 feet [1.82 m] of the Intelligent Return.</li><li>Service that conforms to the following specifications:<ul style="list-style-type: none"><li>100–120 VAC, 1–phase, 60 Hz, 2.5 amps,</li><li>200–240 VAC, 1–phase, 50Hz, 1.5 amps,</li><li>15–20 amp line.</li></ul></li></ul>
<ul style="list-style-type: none"><li>FX System Controller Model 2855</li></ul>	<p>The FX System Controller Model 2855 requires the following:</p> <ul style="list-style-type: none"><li>A single AC power outlet within 6 feet [1.82 m] of the unit,</li><li>Service that conforms to the following specifications:<ul style="list-style-type: none"><li>100–120 VAC, 1–phase, 60 Hz, 2 amps,</li><li>200–240 VAC, 1–phase, 50Hz, 1 amp,</li><li>15–20 amp line, with dedicated, isolated ground circuit described in the following note.</li></ul></li></ul>



**Note:** The FX System Controller Model 2855 requires a dedicated, isolated ground circuit of at least 15 ampere capacity at 100–120 volts.

This circuit may have no other outlets or devices drawing power from it. It must have an insulated grounding wire (color coded green with yellow stripe) run directly from the building main service entrance panel or circuit panel supplying the system to an isolated ground receptacle (orange) in which the grounding terminal is purposely insulated from the mounting box (NEMA 5–15 isolated ground). This circuit is defined in Section 250–74 No. 4 in the National Electric Code Handbook.



- FX Sorter Model 2850
- FX Directional Conveyor Model 2860
- FX Ramp Conveyor Model 2861
- FX Lift-Gate Conveyor Model 2862
- FX Two-Foot Conveyor Model 2863 [61 cm]
- FX Four-Foot Conveyor Model 2864 [122 cm]

These models require the following:

- A single AC power outlet within 6 feet [1.82 m] of the first unit.
- Service that conforms to the following specifications:
  - 100–120 VAC, 1–phase, 60 Hz, 1.5 amps,
  - 200–240 VAC, 1–phase, 50Hz, 0.8 amps,
  - 15–20 amp line.

**Note:** Additional outlets may be required, depending on your system configuration. These FX modules may be daisy-chain connected to AC power, with up to seven modules connected to a single AC power outlet. (Every eighth unit in the sortation system requires an AC power outlet.)

# Environmental requirements

To ensure that the monitor does not overheat, position Intelligent Return Plus units so that they are never in direct sunlight.

Indoor environmental requirements, all models	
Temperature	50° F to 104° F [10° C to 40° C]
Humidity	20% to 60% relative humidity (non-condensing)
Outdoor environmental requirements, Model 2812 or 2822 patron interface mounted into an exterior wall	
Temperature	−20° F to +120° F [−29° C to 49° C]
Humidity	0% to 85% relative humidity (non-condensing)

# Network requirements

The 3M Intelligent Return and Sorter System communicates with the circulation system over a wired Ethernet connection. The Ethernet cable must:

- Meet as a minimum the CAT-5e standard and be terminated with an RJ45 modular plug
- Be long enough to extend from the jack to the FX System Controller Model 2855 with at least two feet (61 cm) of slack
- Be routed away from all traffic areas

## Module weights

Model	Approximate Weight
2810	275 lb [124,7 kg]
2812	275 lb [124,7 kg]
2820	308 lb [139,7 kg]
2822	308 lb [139,7 kg]
2830	320 lb [145 kg]
2850	130 lb [58,9 kg]
2899	47 lb [21,3 kg]

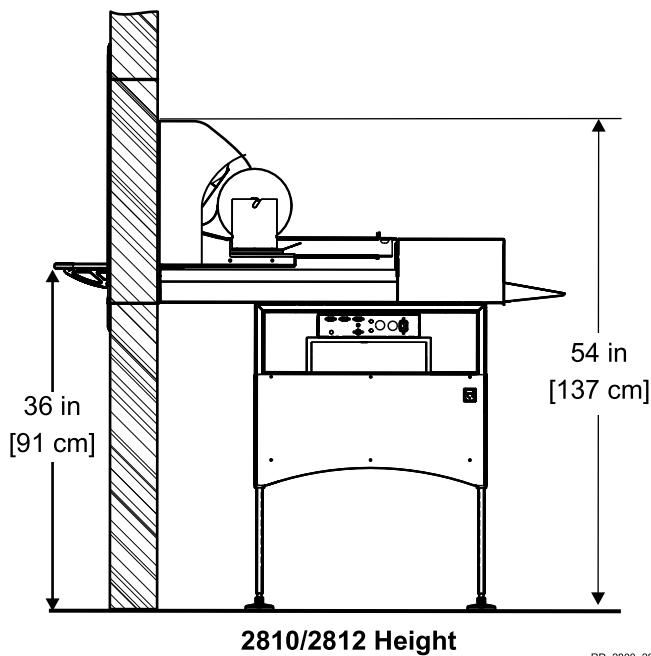
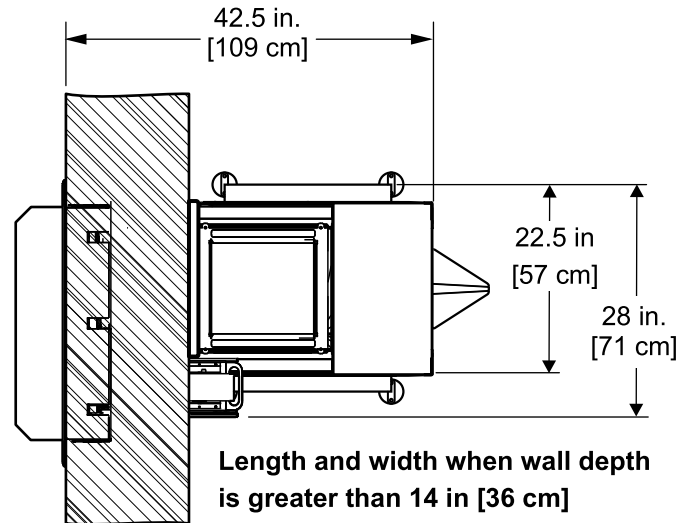
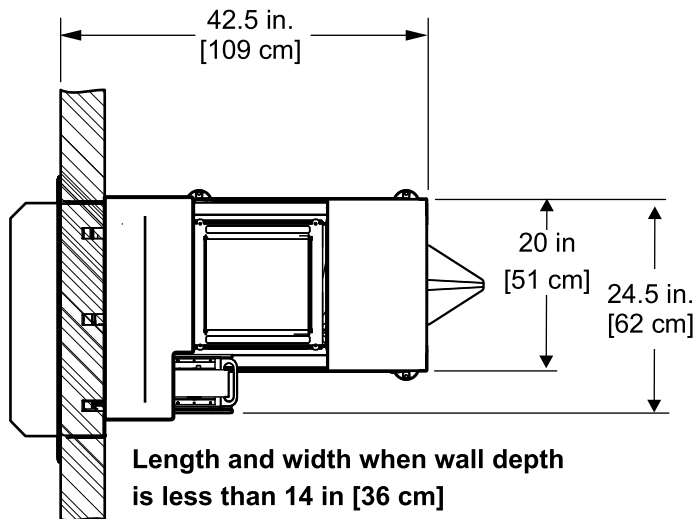
Model	Approximate Weight
2855	175 [79,4 kg]
2860	96 lb [43,5 kg]
2861	150 lb [68,0 kg]
2862	160 lb [72,6 kg]
2863	95 lb [43,1 kg]
2864	150 lb [68,0 kg]

Optional base plate for the Model 2855 weighs 50 lb [22,7 kg].

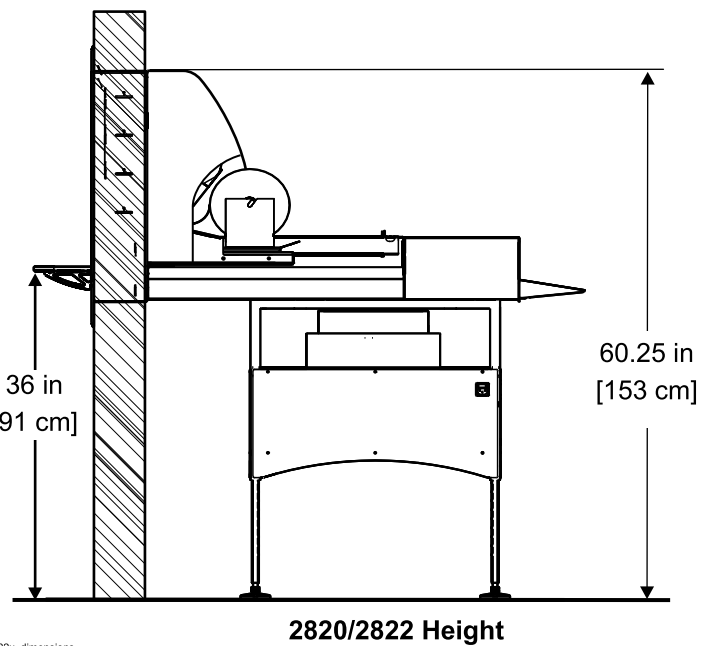
# Module dimensions

## Intelligent Return Classic and Plus (Models 2810, 2812, 2820 and 2822)

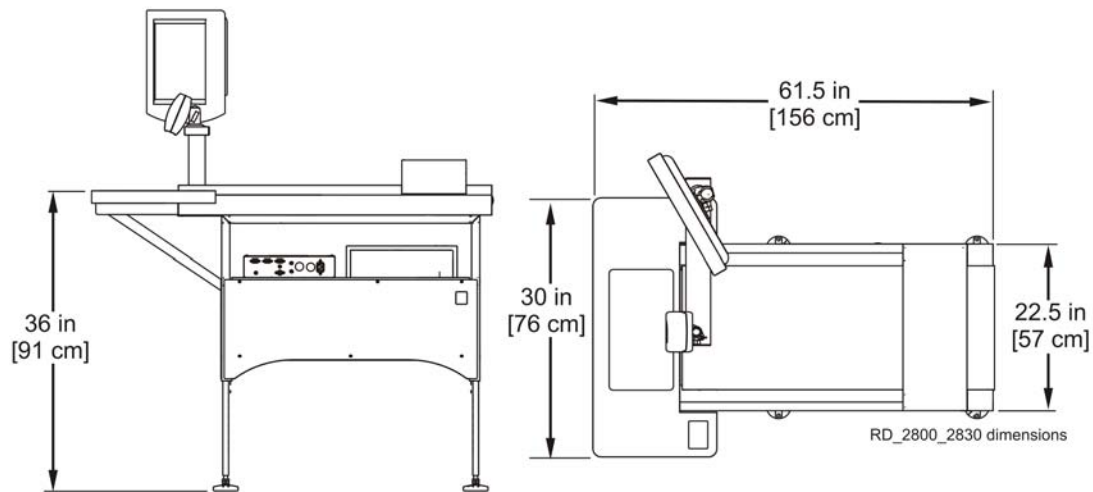
**Note:** When the 3M Intelligent Return is installed in a wall that is thicker than 14 in. [36 cm], it is turned on its frame, which changes the unit's width slightly.



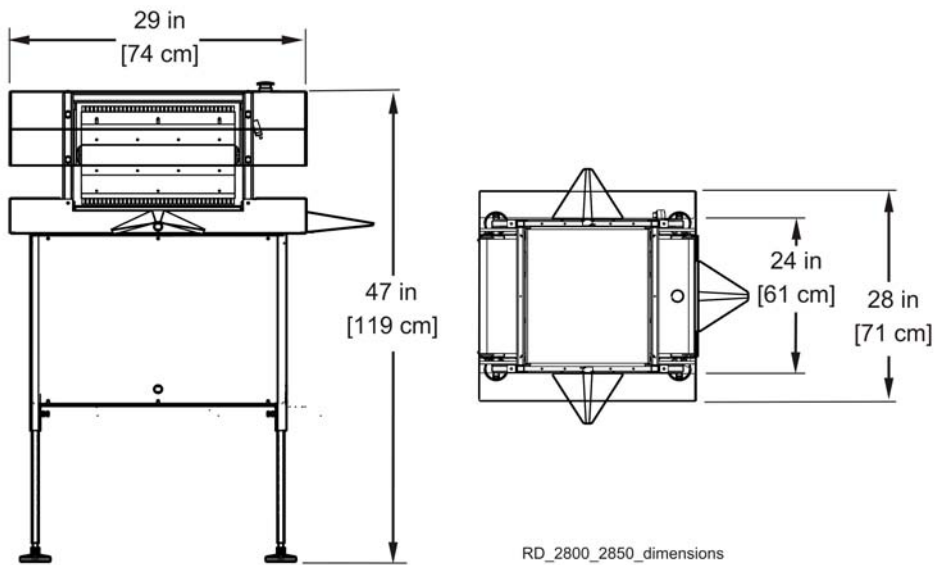
RD\_2800\_281x\_282x\_dimensions



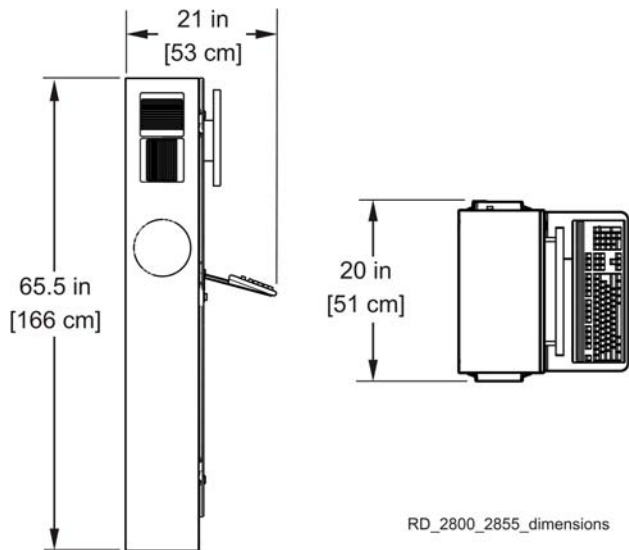
## Intelligent Return Staff Model 2830



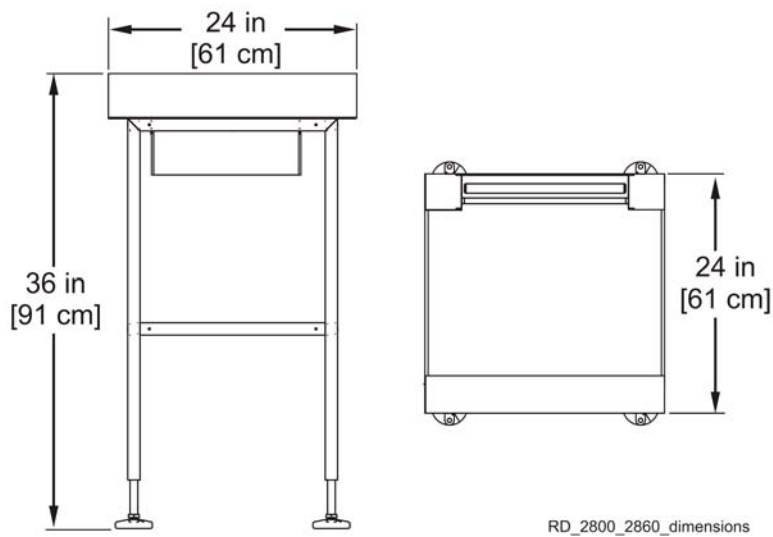
## FX Sorter Model 2850



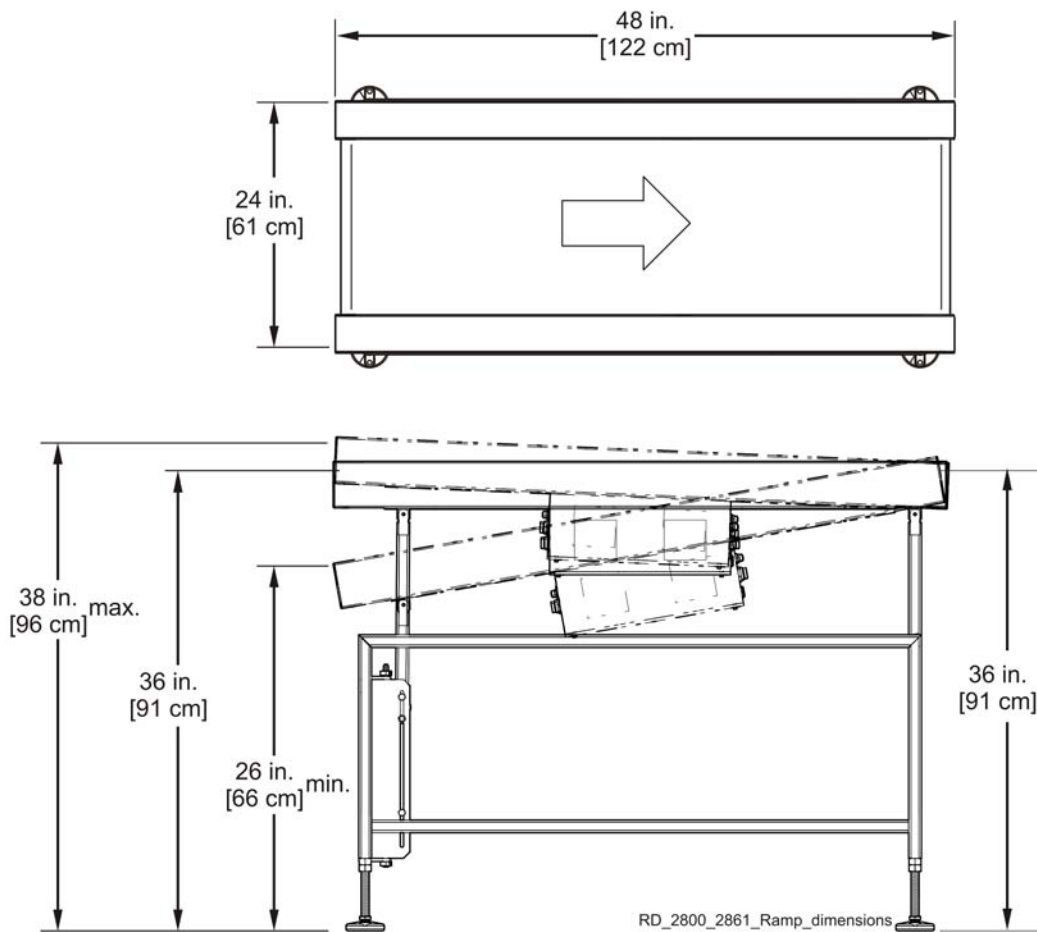
## FX System Controller Model 2855



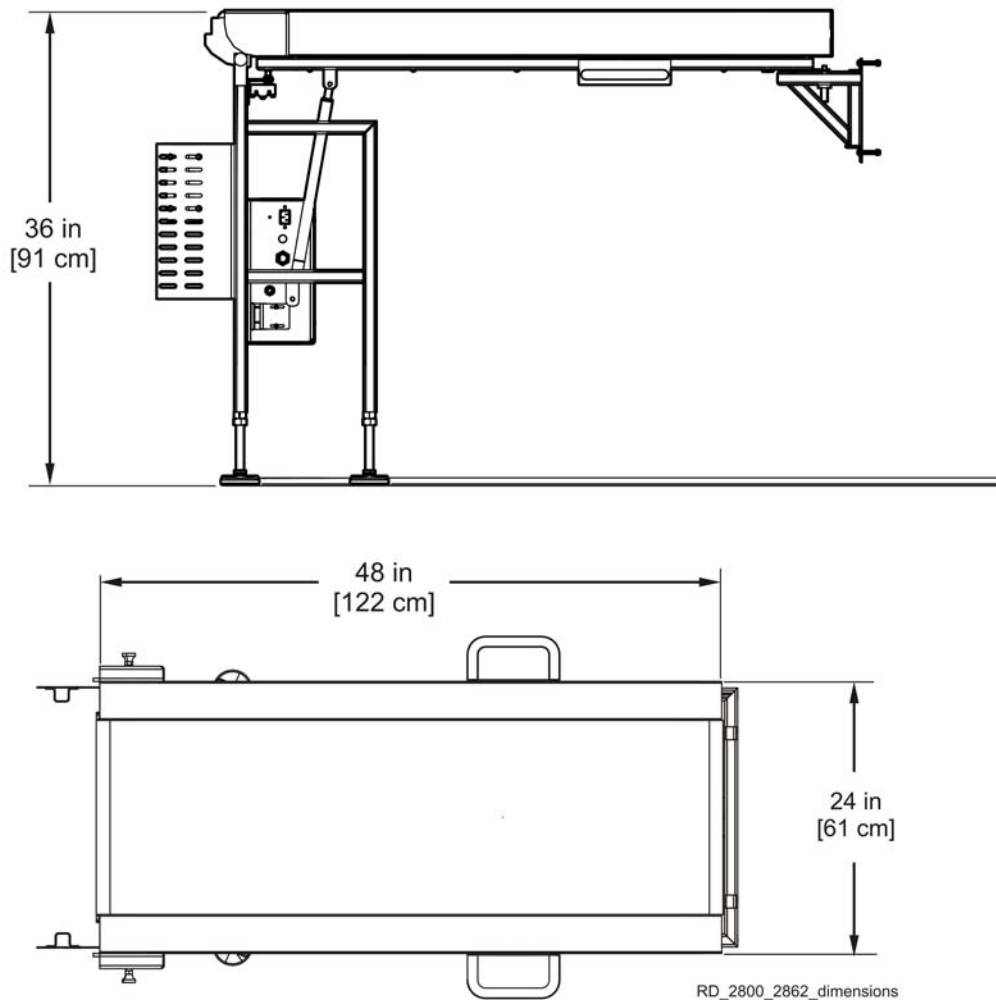
## FX Directional Conveyor Model 2860



## FX Ramp Conveyor Model 2861

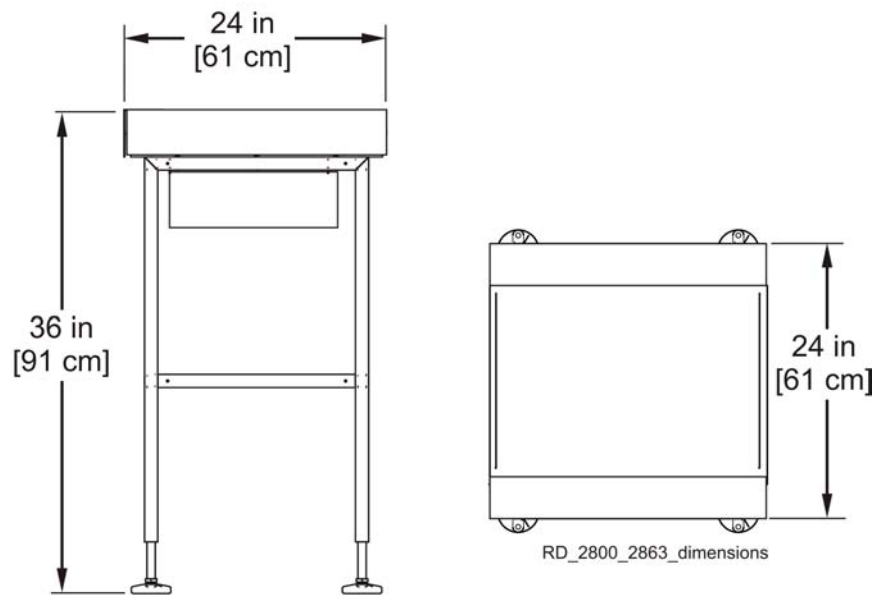


## FX Lift-Gate Conveyor Model 2862

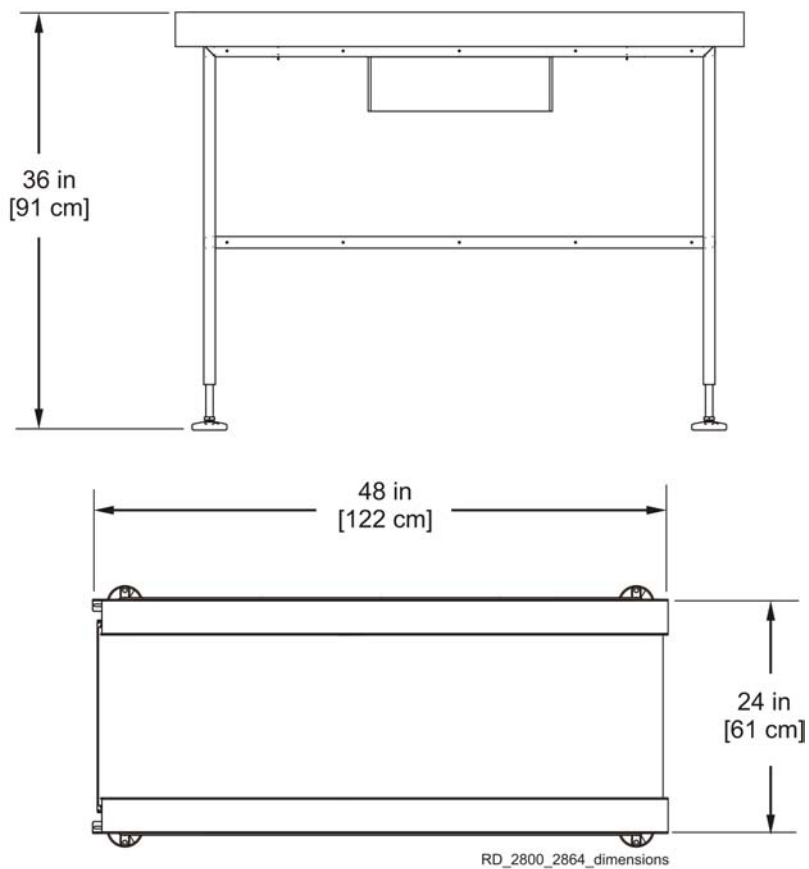




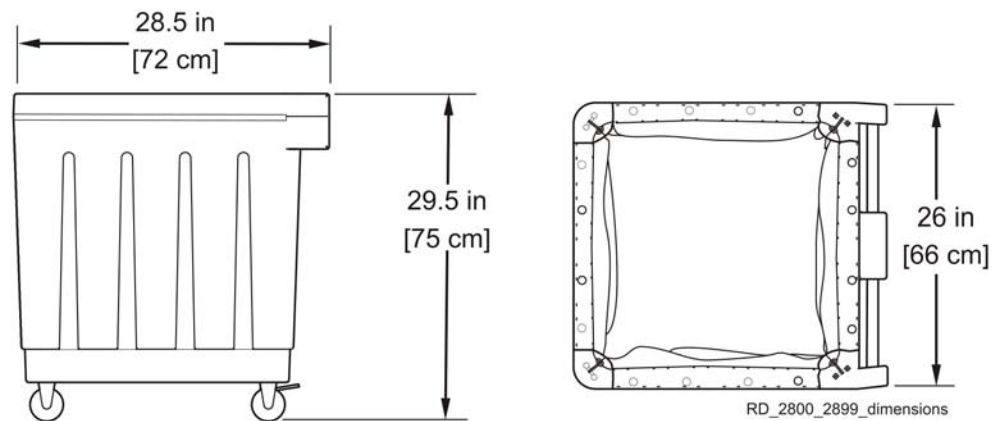
## FX Two-Foot Conveyor Model 2863



## FX Four-Foot Conveyor Model 2864



Model 2899



# Wall construction: Models 2810 and 2812

This section provides wall construction requirements for 3M Intelligent Return Classic units.

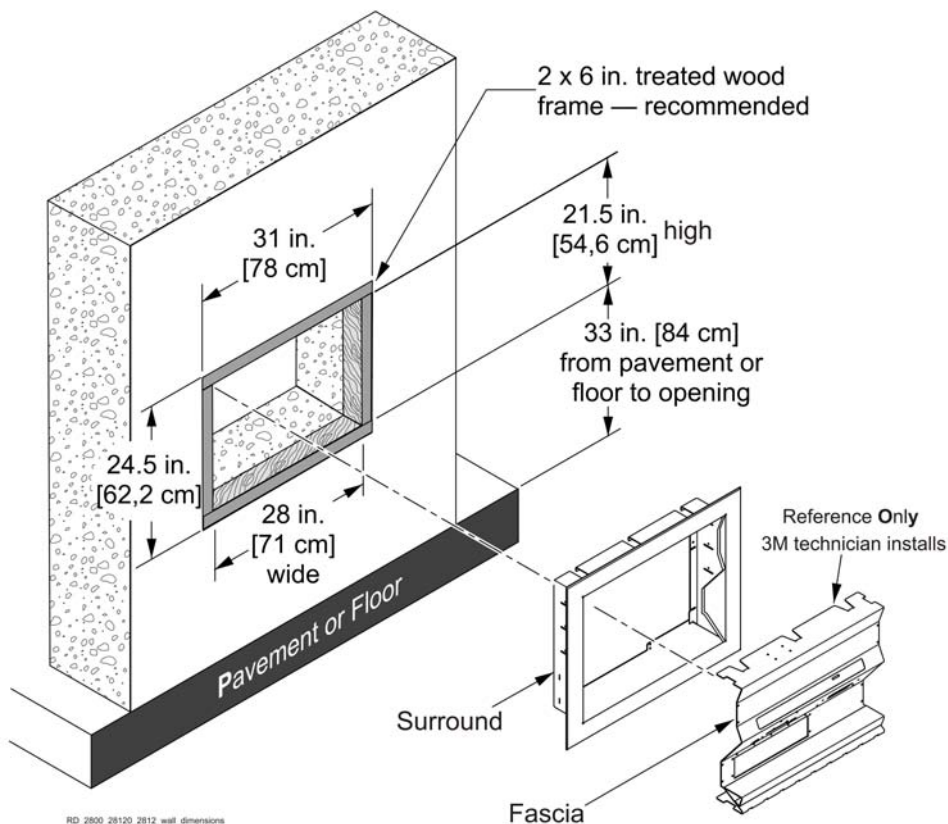
**Before beginning new construction or changing an existing structure, contact 3M Library Systems Technical Service at 1-800-328-0067 (website: <http://www.3M.com/library>) or your sales representative to:**

- **Confirm that you have the most recent version of this document.**
- **Verify that the proposed system can be installed in the planned space.**

## Front elevation

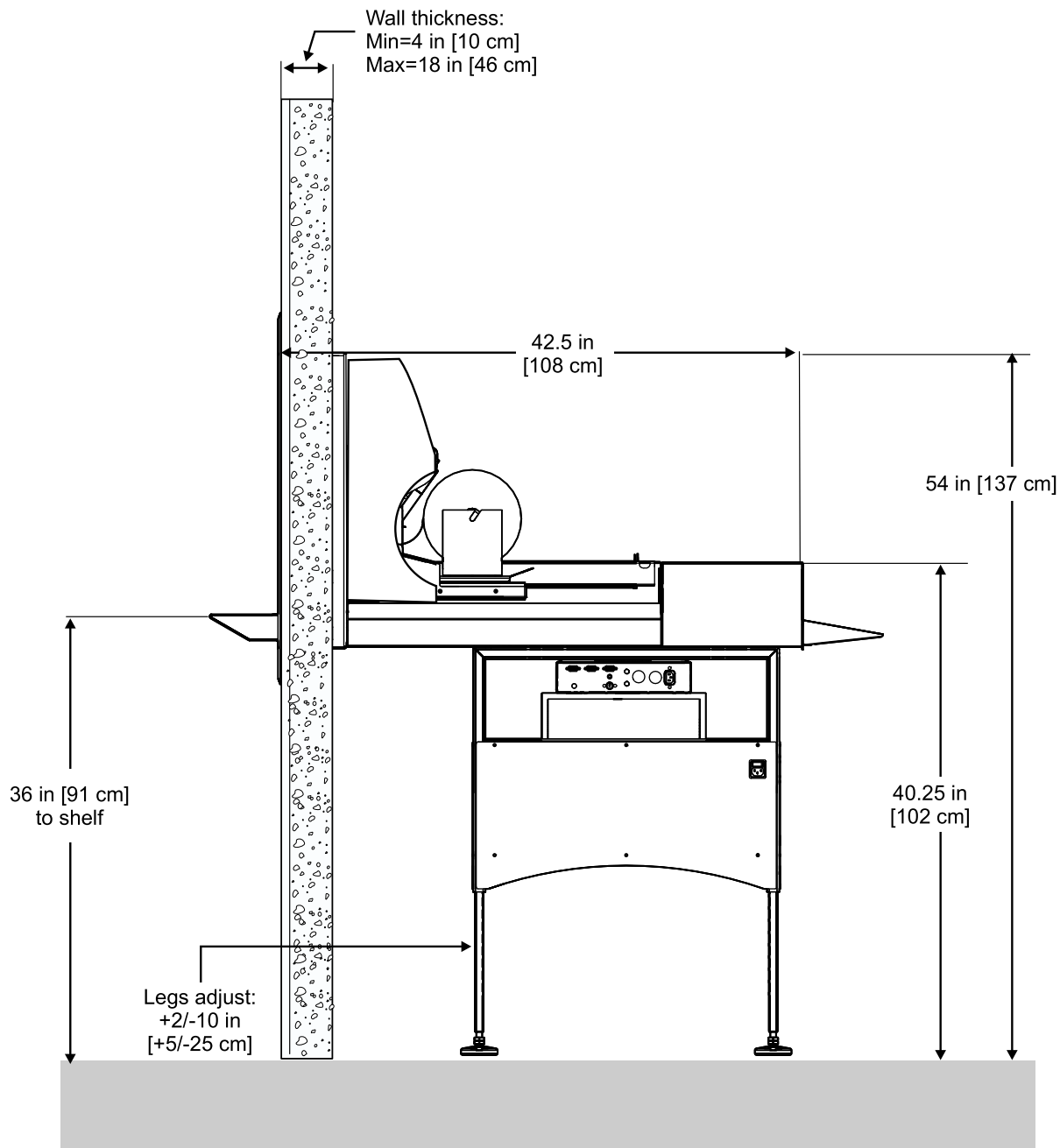
- The system requires a wall opening that is 28 inches wide × 21.5 inches high [71 cm wide × 54,6 cm high].
- The surround adds a 3 in. (7.6 cm) border around the opening.
- The wall opening requires framing material that will readily accept the screws required to anchor the surround. This material cannot be concrete, brick, or rock of any kind. 3M recommends 2 x 6 inch treated wood framing.
- The system can be installed in walls with depths that range from 4 in. (10 cm) minimum to 18 in. (46 cm) maximum.
- 3M recommends that the bottom of the wall opening be 33 in. (84 cm) from the floor or pavement. This will place the shelf at a height of 36 in. (91 cm), which is an ADA requirement. This measurement should be taken from the patron side of the wall.

### Front elevation (3M Intelligent Return Classic models 2810/2812)



## Side elevation

Side elevation (3M Intelligent Return Classic Model 2810/2812)



RD\_2800\_Classic\_Side\_View

## Wall thickness and weight bearing capacity

- The system can be installed in walls that are between 4 in. to 18. in [10 to 46 cm] thick.
- The wall should be strong enough to bear the weight of the 3M Intelligent Return, which means it should be able to handle the additional 225 lb. [102 kg] when the system is placed on it.

# Wall construction: Models 2820 and 2822

This section provides wall construction requirements for 3M Intelligent Return Plus models.

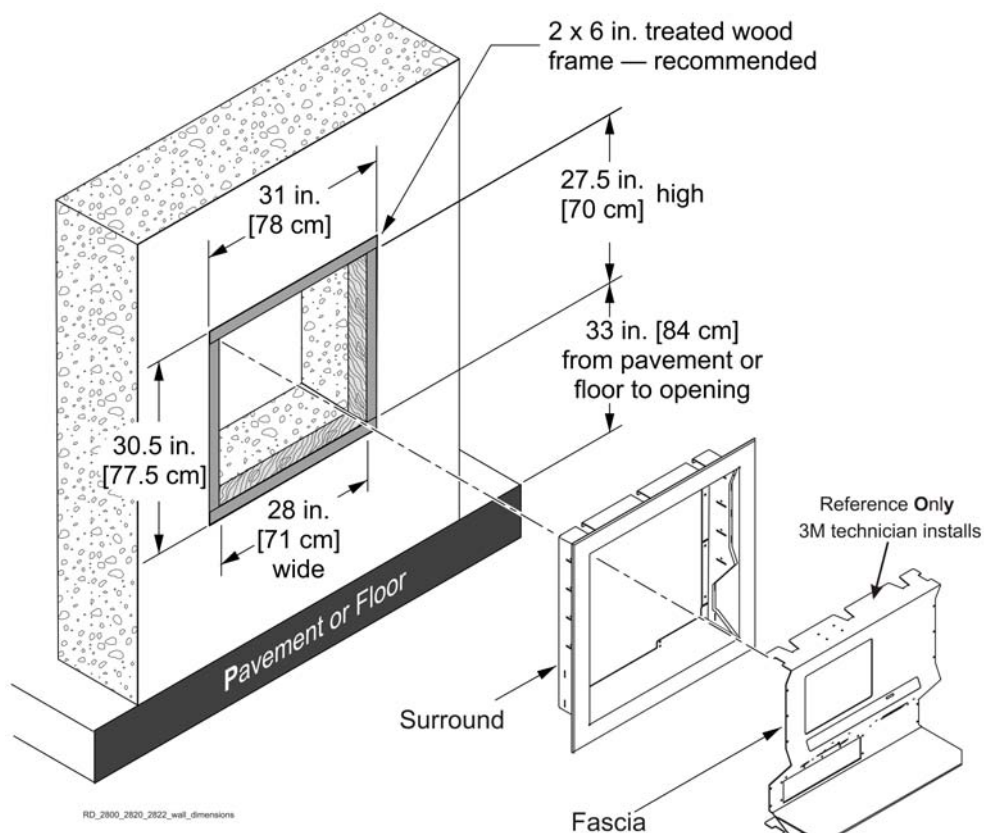
**Before beginning new construction or changing an existing structure, contact 3M Library Systems Technical Service at 1-800-328-0067 (website: <http://www.3M.com/library>) or your sales representative to:**

- **Confirm that you have the most recent version of this document.**
- **Verify that the proposed system can be installed in the planned space.**

## Front elevation

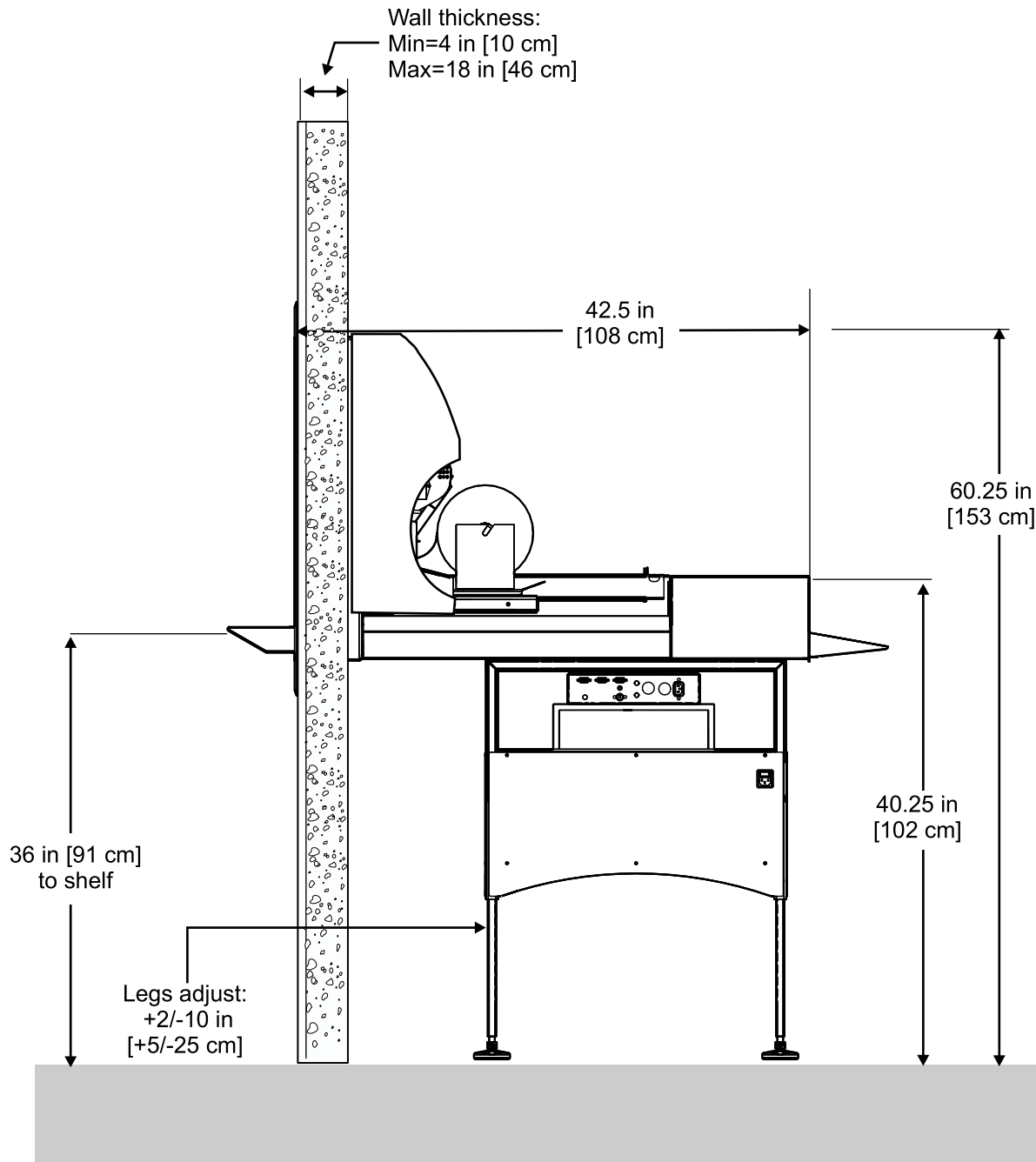
- The system requires a wall opening that is 28 inches wide × 27.5 inches high [71 cm wide × 70 cm high].
- The surround adds a 3 in. (7.6 cm) border around the opening.
- The wall opening requires framing material that will readily accept the screws required to anchor the surround. This material cannot be concrete, brick, or rock of any kind. 3M recommends 2 x 6 inch treated wood framing.
- The system can be installed in walls with depths that range from 4 in. to 18 in. (10 cm to 46 cm).
- 3M recommends that the bottom of the wall opening be 33 in. (84 cm) from the floor or pavement. This will place the shelf at a height of 36 in. (91 cm), which is an ADA requirement. This measurement should be taken from the patron side of the wall.

### Front elevation (3M Intelligent Return Plus)



## Side elevation

### Side elevation (3M Intelligent Return Plus)



RD\_2800\_Plus\_Side\_View

## Wall thickness and weight bearing capacity

- The system can be installed in walls that are between 4 in. to 18. in [10 to 46 cm] thick.
- The wall should be strong enough to bear the weight of the 3M Intelligent Return, which means it should be able to handle the additional 225 lb. [102 kg] when the system is placed on it.

# Space requirements and recommendations

## Minimum distances between RFID systems

This section lists minimum distances required between 3M RFID systems in order to avoid RF interference. In some situations, these distances may not be sufficient, though this can only be determined on-site. Specific systems may have additional requirements regarding cable routing, power supplies, other sources of interference and space for clearance for maintenance, workflow, and other considerations. See the sections that address these issues in the applicable *Site Planning Guide* or *Architect/Contractor's Package*.

### Minimum distances between RFID systems to avoid interference

	<b>811 812 813 814 946</b>	<b>SelfCheck 895</b>	<b>2800† 3100†</b>	<b>Lyngsoe Systems†</b>	<b>877 plastic chute</b>	<b>877 metal chute</b>	<b>8800</b>	<b>8900 8900B 9900</b>	<b>9100</b>
<b>811 812 813 814 946</b>	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	3 ft. 91 cm	8.2 ft. 2,5 m	3 ft. 91 cm
<b>SelfCheck 895</b>	2 ft. 61 cm	4ft.** 1,2 m	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	3 ft. 91 cm	8.2 ft. 2,5 m	3 ft. 91 cm
<b>2800 3100</b>	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	3 ft. 91 cm	8.2 ft. 2,5 m	3 ft. 91 cm
<b>Lyngsoe System</b>	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	4 ft. 1,2 m	4 ft. 1,2 m	3 ft. 91 cm	15 ft. 4,6 m	3 ft. 91 cm
<b>877 plastic chute</b>	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	4 ft. 1,2 m	4 ft. 1,2 m	4 ft. 1,2 m	4 ft. 1,2 m	15 ft. 4,6 m	4 ft. 1,2 m
<b>877 metal chute</b>	2 ft. 61 cm	2 ft. 61 cm	2 ft. 61 cm	4 ft. 1,2 m	4 ft. 1,2 m	1 ft. 30 cm	3 ft. 91 cm	15 ft. 4,6 m	3 ft. 91 cm
<b>8800</b>	3 ft. 91 cm	3 ft. 91 cm	3 ft. 91 cm	3 ft. 91 cm	4 ft. 1,2 m	3 ft. 91 cm	3 ft. 91 cm	15 ft. 4,6 m	3 ft. 91 cm
<b>8900 8900B 9900</b>	8.2 ft. 2,5 m	8.2 ft. 2,5 m	8.2 ft. 2,5 m	15 ft. 4,6 m	15 ft. 4,6 m	15 ft. 4,6 m	15 ft. 4,6 m	15 ft * 4,6 m	15 ft 4,6 m
<b>9100</b>	3 ft. 91 cm	3 ft. 91 cm	3 ft. 91 cm	3 ft. 91 cm	4 ft. 1,2 m	3 ft. 91 cm	3 ft. 91 cm	15 ft. 4,6 m	5 ft # 1,5 m

\* Model 8900 systems can be placed closer than 15 feet [4,6 m] apart when they are connected by sync cable. See the discussion in the *Model 8900 Architect/Contractor's Package*. Model 8900B and Model 9900 systems, or “mixed” environments that include an 8900B and a 9900 system (which use common electronics), can be placed closer than 15 feet [4,6 m] apart when systems are connected by sync cable. See the discussion in the *Model 8900B or Model 9900 Architect/Contractor's Package*.

\*\* Four foot [1,2 m] minimum applies to all 895 pad units and SelfCheck™ units without a cabinet. For SelfCheck™ units enclosed in a cabinet, there are no distance restrictions.

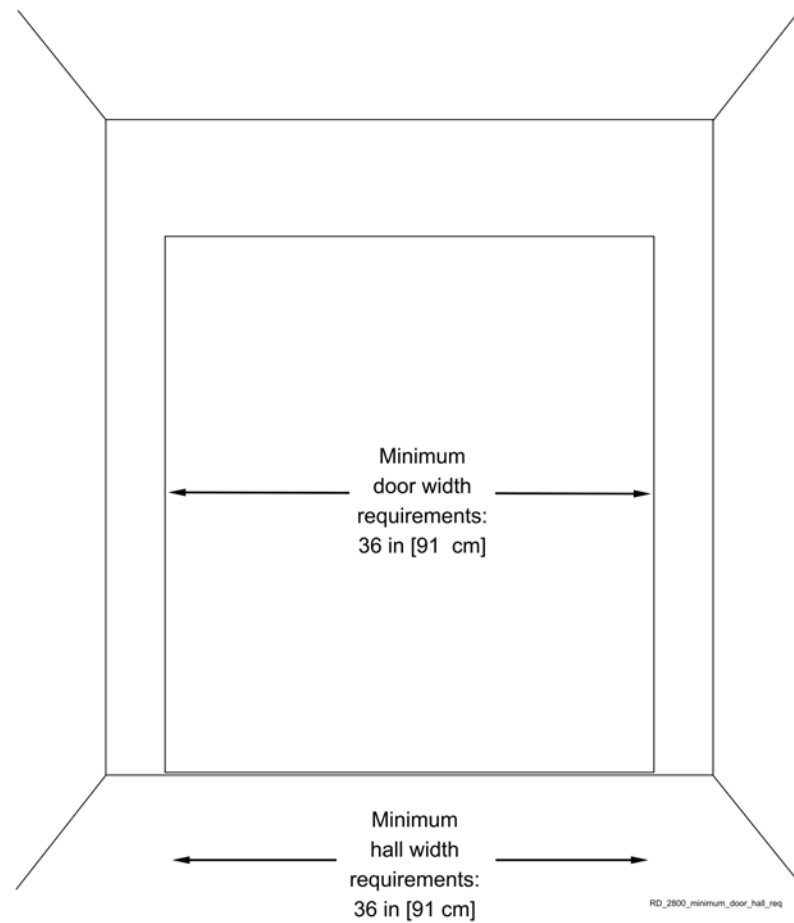
# This restriction can be worked around by creating a single large system by running lattice to lattice cables between “systems.” This combined system cannot exceed eight lattices.

† Measurement is from the RFID reader.

## Minimum access requirements

The hallway and access doors between the shipping area where the system is received and the room that will house the 3M Intelligent Return and Sorter System must meet the specifications shown in the figure in order to move the system into place.

### Access requirements



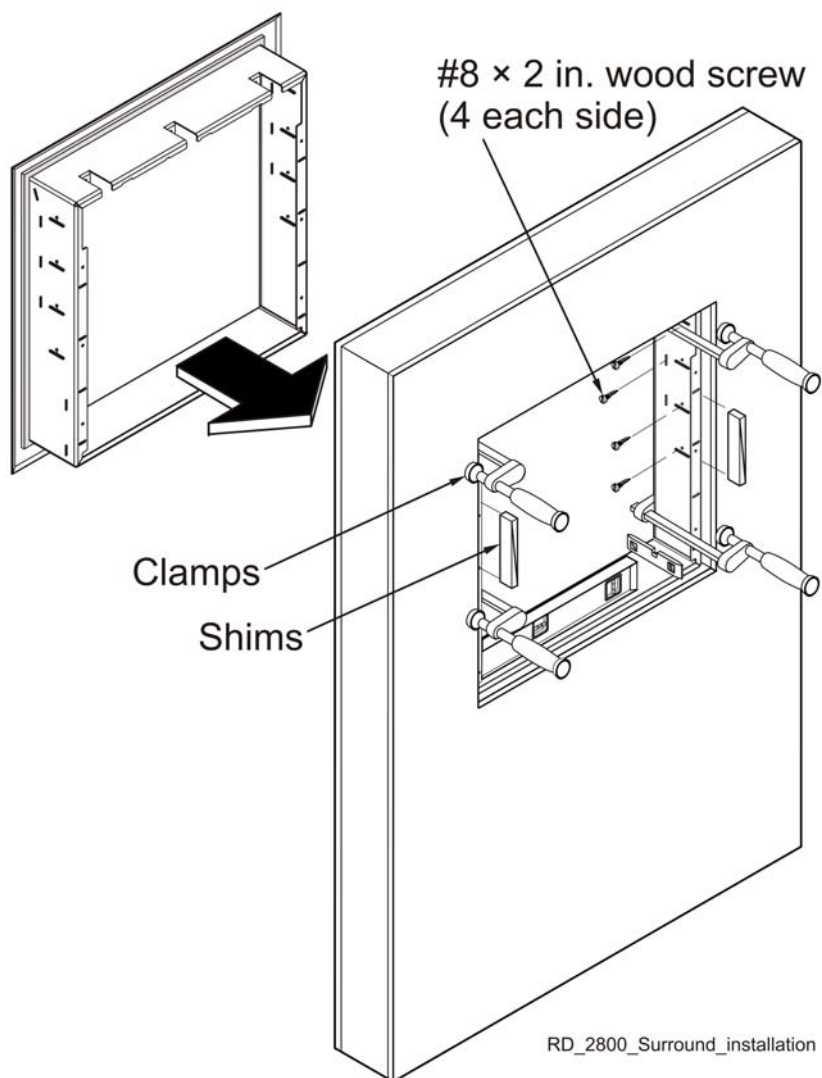


## Install the surround

Install the surround for the Intelligent Return system fascia.

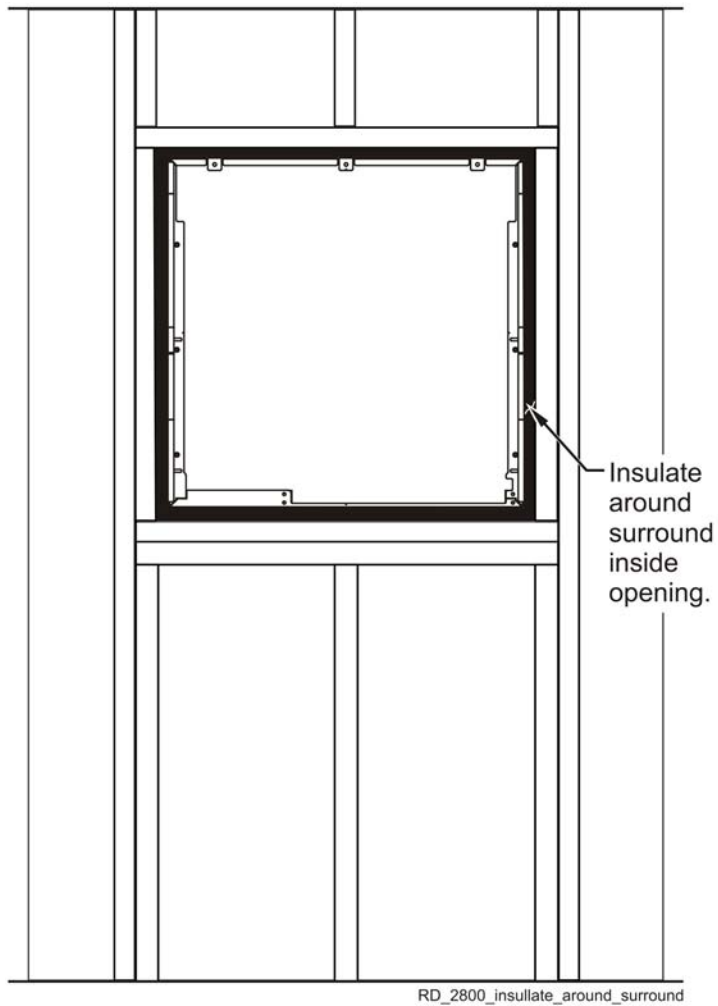
- Verify that the surface of the bottom of the surround opening is the correct distance from the ground, which is approximately 33 in. [84 cm] from the floor or pavement on the patron side of the wall to the inside (top) surface of the surround bottom sill.
- Use a two-foot level and torpedo level on the surround sill surface to level the surround.
- Fasten the surround securely in place by at least eight #8 × 2 in. (four each side) wood screws and flat washers through the surround walls into the surrounding wall studs. Install shims in appropriate locations to maintain the surround position.

### Install the surround



# Insulate the surround of outdoor units

Insulate around the surround of outdoor units.



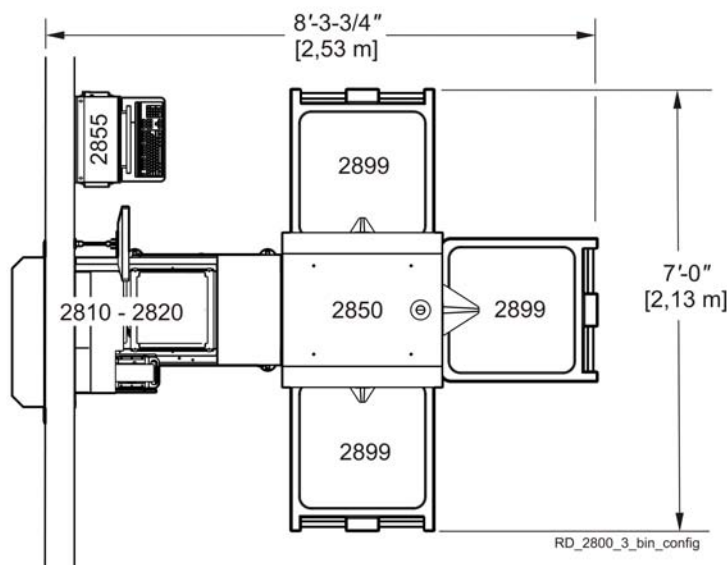
# Sample configurations

The information in this section provides insight on the space required for various configurations of the 3M Intelligent Return and Sorter System FX. However, please keep the following in mind:

- Other configurations are possible. The 3M Intelligent Return and Sorter System FX is a flexible system, so there are other ways to arrange the system to meet your needs.
- The information in this section should not be used as a substitute for taking exact measurements and consulting with 3M Technical Service to ensure that adequate space is available and other facility requirements met for the system you intend to install.

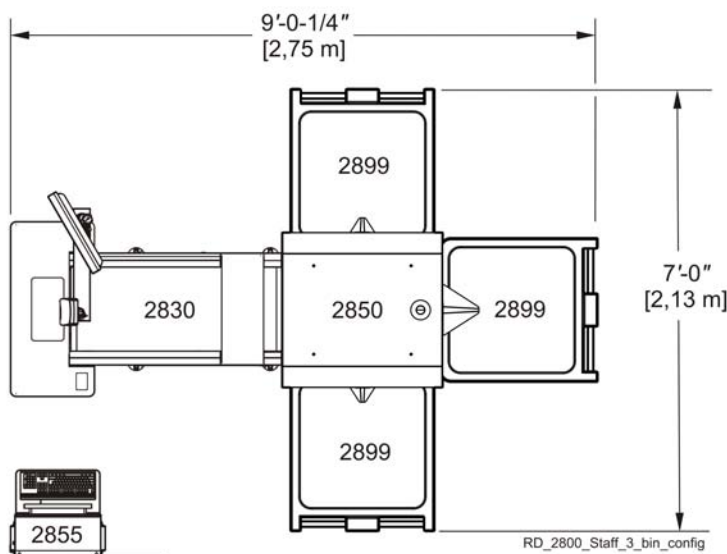
## Three bin configuration

The illustration at right shows a three bin configuration with approximate space requirements. Please contact 3M Technical Service before making a final determination on the space required to install a system.



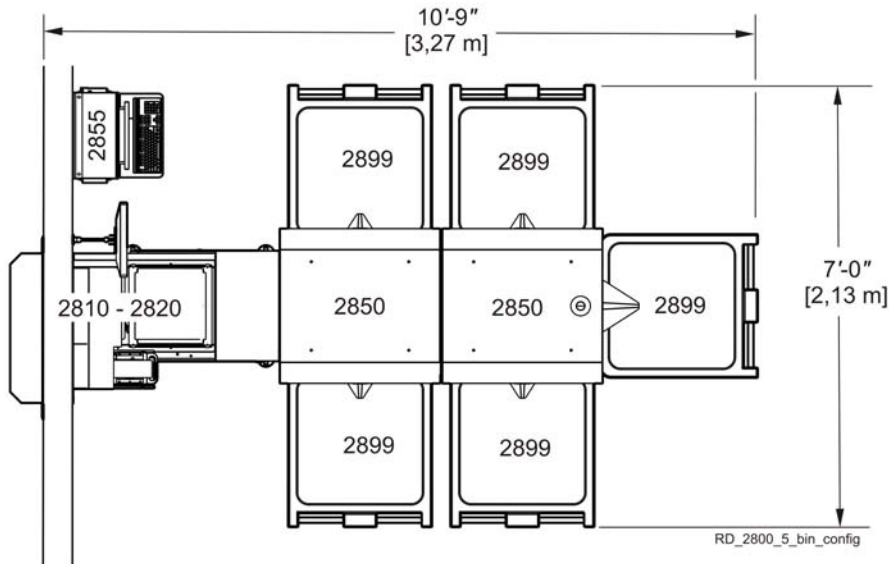
## Three bin configuration with Staff Intelligent Return

The illustration at right shows approximate space requirements for a Staff Intelligent Return with sorter and three bins. Please contact 3M Technical Service before making a final determination on the space required to install a system.



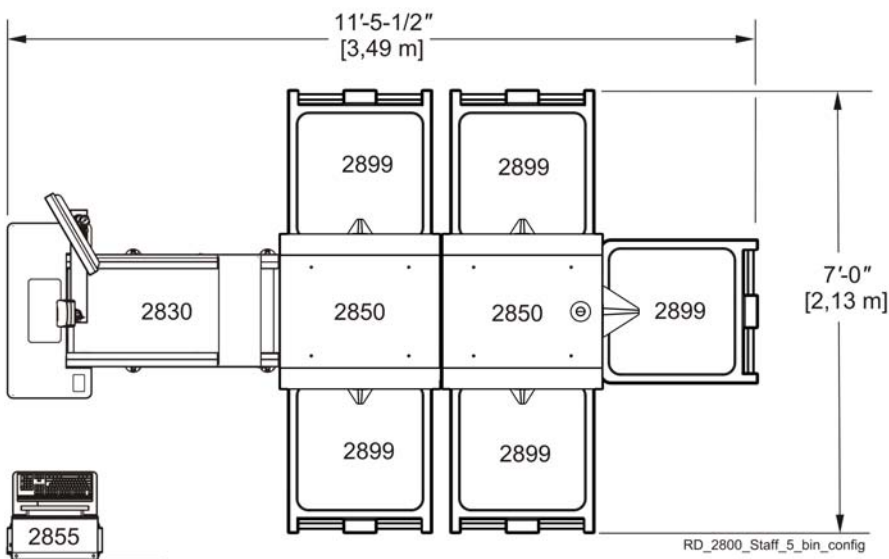
## Five bin configuration

The following is an illustration of a five bin configuration with approximate space requirements. Please contact 3M Technical Service before making a final determination on the space required to install a system.



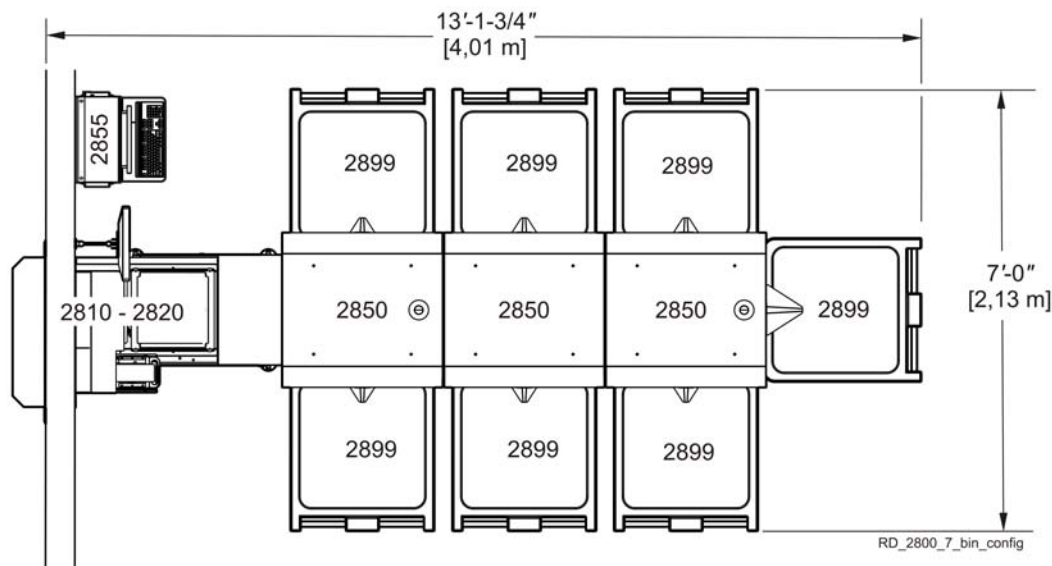
## Five bin configuration with Staff Intelligent Return

The following illustration shows approximate space requirements for a Staff Intelligent Return with sorters and five bins. Please contact 3M Technical Service before making a final determination on the space required to install a system.



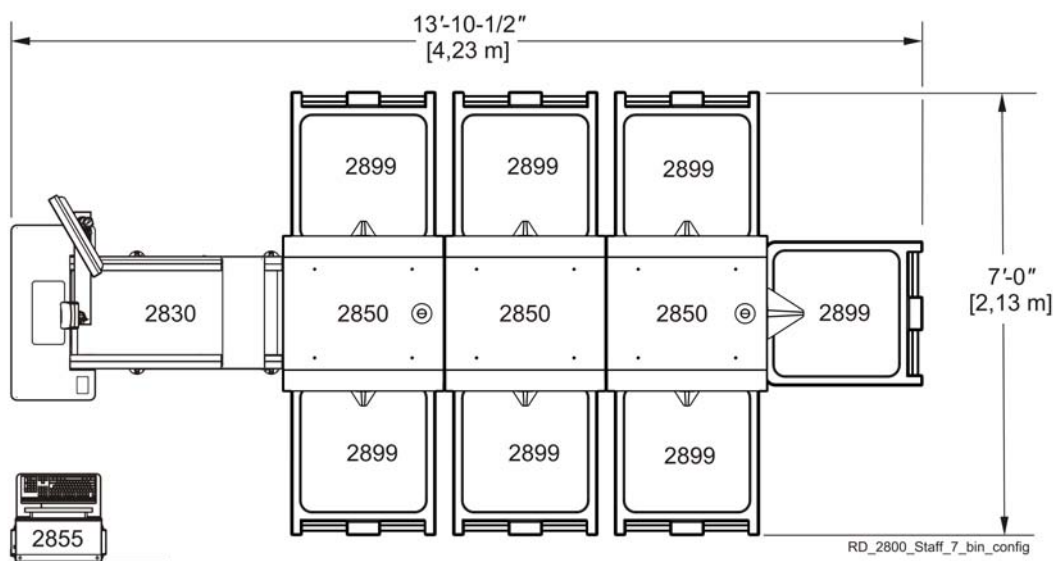
## Seven bin configuration

The following is an illustration of a seven bin configuration with approximate space requirements. Please contact 3M Technical Service before making a final determination on the space required to install a system.



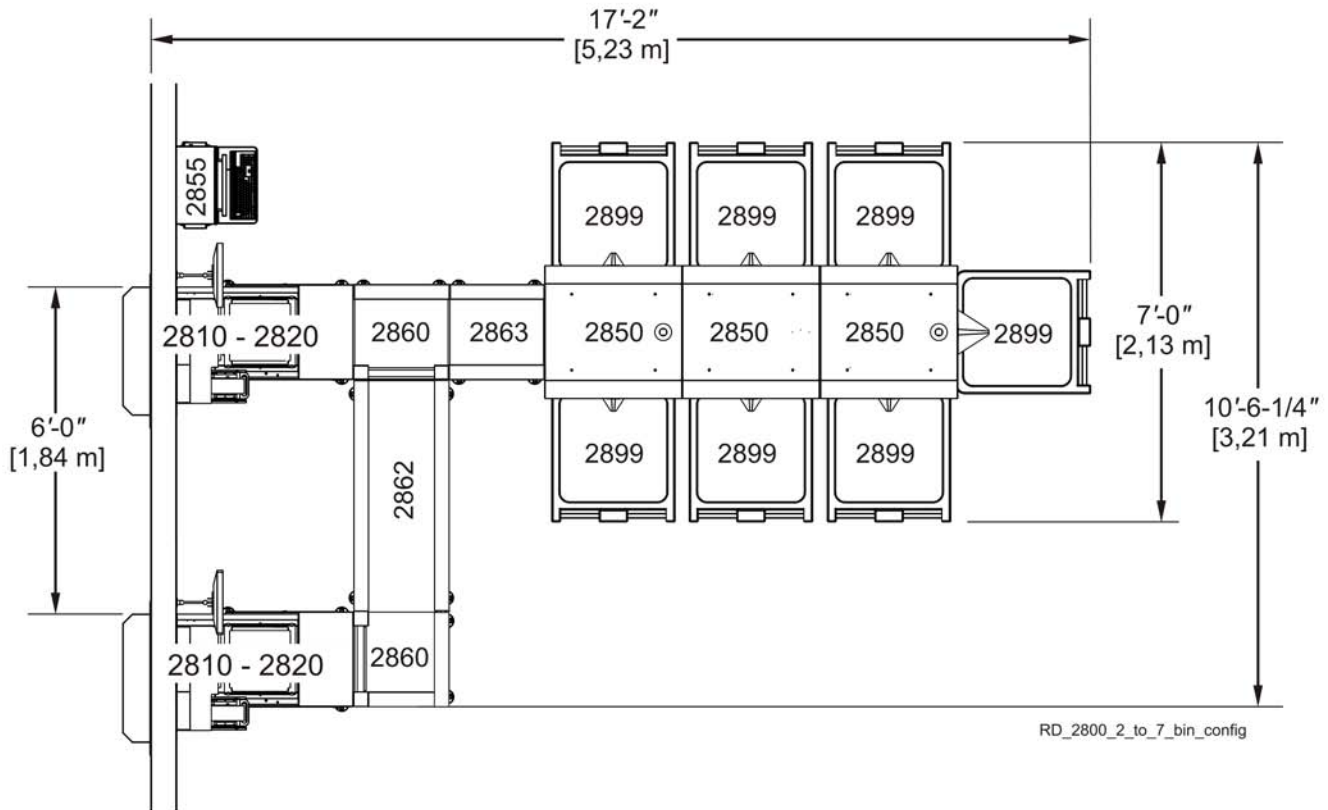
## Seven bin configuration with Staff Intelligent Return

The following illustration shows approximate space requirements for a Staff Intelligent Return with sorters and seven bins. Please contact 3M Technical Service before making a final determination on the space required to install a system.



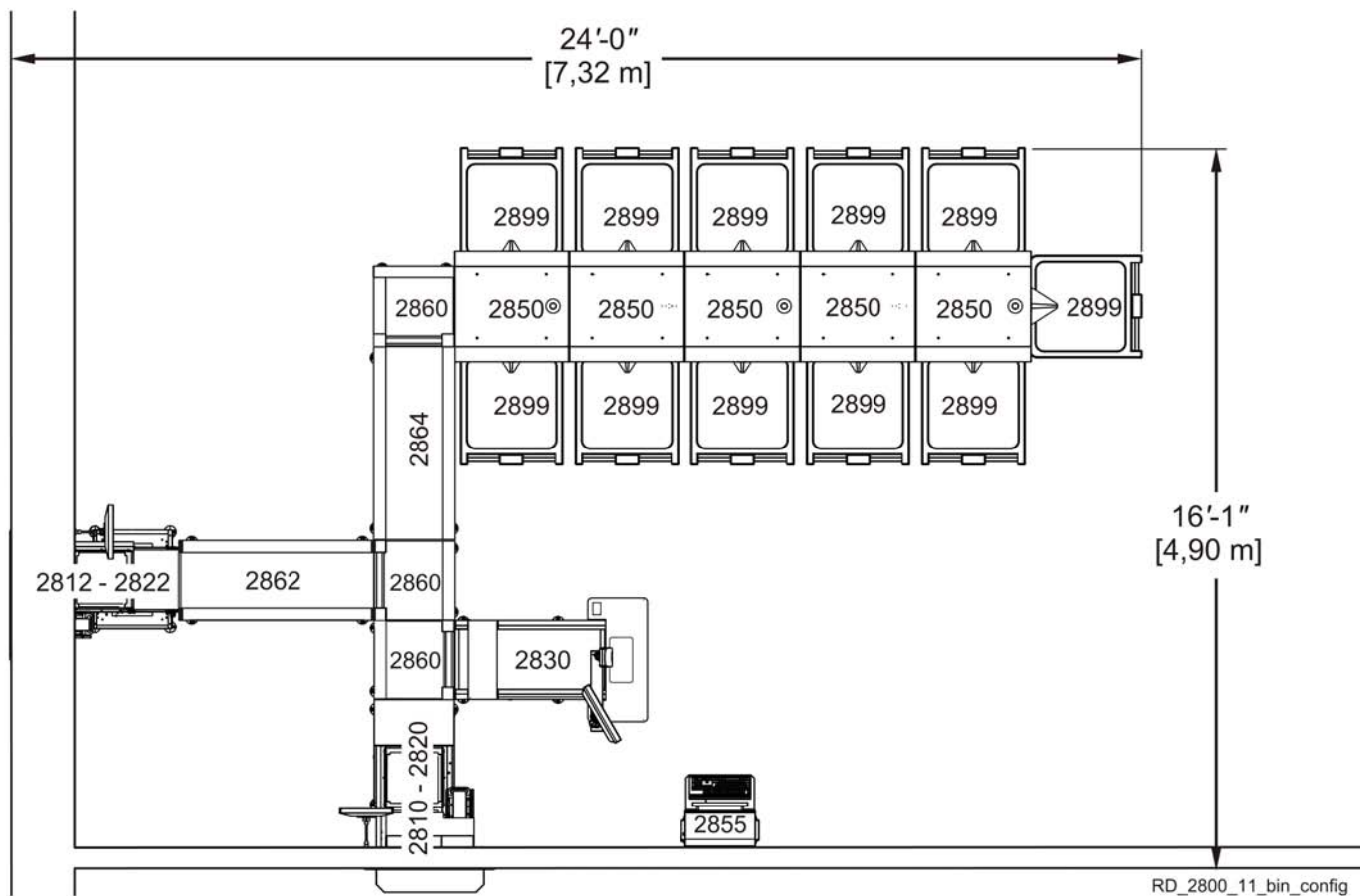
# Seven bin configuration from two Intelligent Returns

The following illustration shows approximate space requirements for sortation to seven bins from two Intelligent Returns. Please contact 3M Technical Service before making a final determination on the space required to install a system.



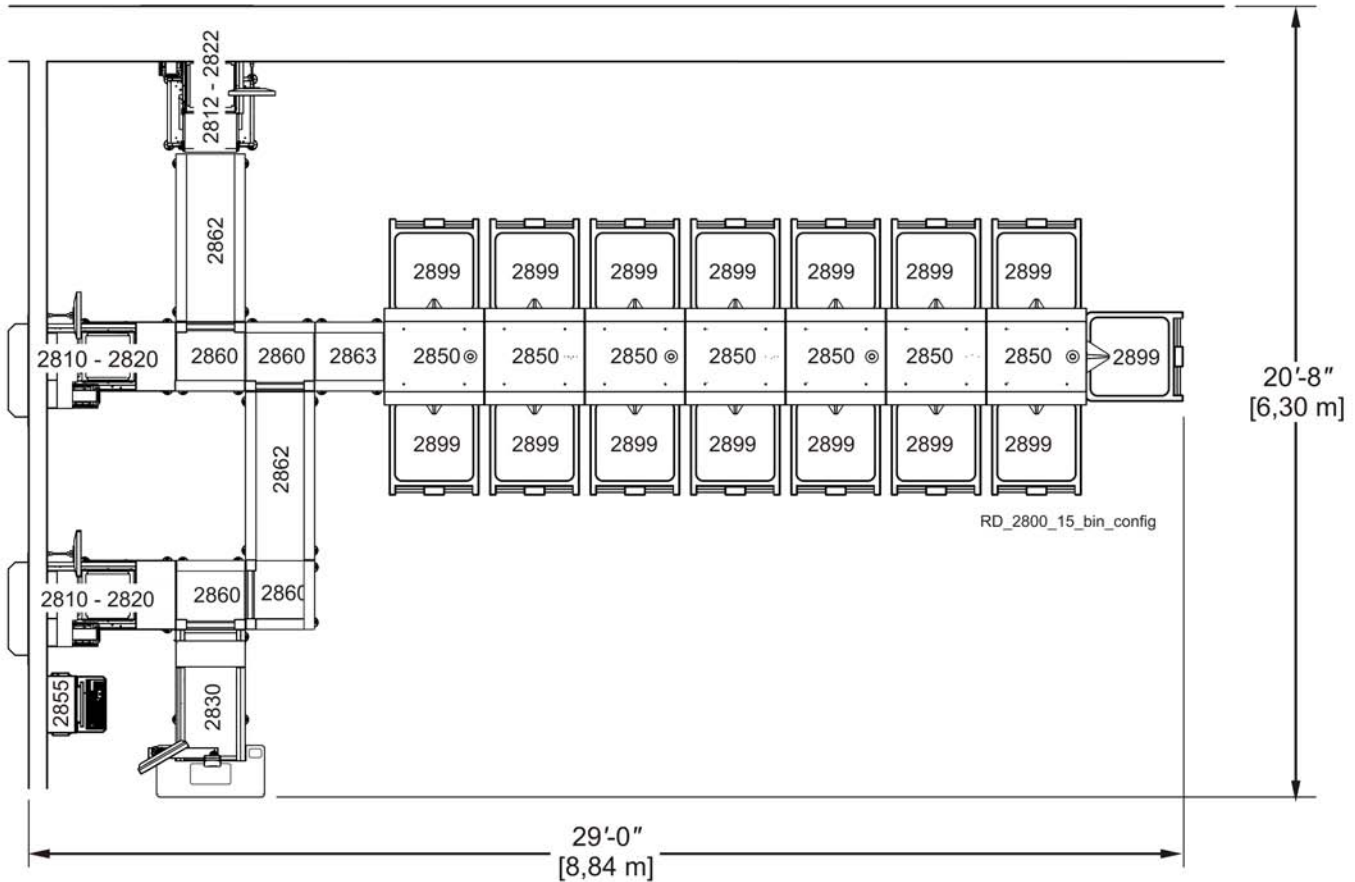
## Eleven bin configuration

The following is an illustration of an eleven bin configuration with approximate space requirements. Please contact 3M Technical Service before making a final determination on the space required to install a system.



## Fifteen bin configuration

The following is an illustration of a fifteen bin configuration with approximate space requirements. Please contact 3M Technical Service before making a final determination on the space required to install a system.





# Warranty

*Effective 12-12-05*

**One Year Library Systems Product Performance Guarantee:** Subject to the Limitation of Liability below, 3M guarantees your satisfaction with the performance of any 3M Library System Product for 12 months from the date of installation provided that a) you are the original purchaser; b) you have executed a one (1) year 3M Service Agreement for maintenance of the Library System product; and c) the product has not been subjected to abuse, misuse, accident or neglect. Performance means the product meets 3M published product specifications. If you are not completely satisfied with the performance of your Library System Product, you may return the Library System product for a prompt refund. 3M will pay all reasonable de-installation and shipping charges to return the product to 3M. Note that all claims under this guarantee must be submitted to 3M within 12 months from the date of installation of the 3M Library Systems Product. Failure to submit a claim within this time frame will invalidate this guarantee. **IMPORTANT:** Consumables and non-3M branded products are excluded from this Guarantee.

**Warranty and Limited Remedy for Non-Software Library Systems Products Not Covered by Performance Guarantee:** Unless stated otherwise in 3M product literature or packaging, 3M warrants that each 3M Library Systems Product meets the applicable specifications for a period of ninety (90) days from the date of shipment (or, in the case of hardware installed by 3M, from the date of installation). Any warranties related to 3M software are contained in separate 3M software licenses. Consumables and non-3M branded products are excluded from this Warranty and Limited Remedy.

**3M MAKES NO OTHER GUARANTEES, WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY OR CONDITION ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE.** You are responsible for determining whether the 3M product is fit for a particular purpose and suitable for your application. If the 3M product is defective within the warranty period and provided that a) the product has not been subjected to abuse, misuse, accident or neglect and b) you have notified 3M within thirty (30) days after the defect was discovered, your exclusive remedy and 3M's and seller's sole obligation will be, at 3M's option, to replace or repair the defective 3M product.

**Limitation of Liability:** EXCEPT WHERE PROHIBITED BY LAW, 3M AND SELLER WILL NOT BE LIABLE FOR ANY LOSS OR DAMAGE ARISING FROM 3M LIBRARY SYSTEMS, WHETHER DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL, REGARDLESS OF THE LEGAL THEORY ASSERTED, INCLUDING WARRANTY, CONTRACT, NEGLIGENCE OR STRICT LIABILITY.

**Guarantee and Warranty Claims:** For guarantee and warranty claims, and for service, contact our service representatives at 1-800-328-0067

**Track and Trace Solutions  
3M Center Building 225-4N-14  
St. Paul, MN 55144-1000**

**Ver121205**

# 3M Service

## 3M Service phone numbers

For questions regarding your system, call one of the following numbers.

**In the United States**

1-800-328-0067

**In Canada**

English 1-800-268-6235  
Français 1-800-567-3193

**In other countries**

Call your local 3M office.

## 3M Library Systems Web Site

The 3M Library Systems Web site can be located at <http://www.3M.com/library>.

For additional information in the United States about 3M Library Systems, go to <http://www.3M.com/us/library>.

**3M Library Systems**  
3M Center, Building 225-4N-14  
St. Paul, MN 55144-1000  
[www.3M.com/library](http://www.3M.com/library)

## APPENDIX D: CITY OF SANTA MONICA IT SPECIFICATIONS

## CITY OF SANTA MONICA SINGLE MODE FIBER OPTIC SPECIFICATIONS

NOTE: ALL FIBER OPTIC CABLE INSTALLATION, SPLICING AND TERMINATIONS WILL BE COMPLETED BY CERTIFIED CORNING TECHNICIANS.

If fiber terminations occur inside a building, we require 19" rack mount Corning housings, preferably Pretium PCH-01U (24 ports or less – use 2 units if up to 48 ports) or PCH-04U (up to 144 ports). These include space for splicing in rear. Label front cover with remote fiber locations.

12 fiber Corning splice trays, Type 2S (Corning P/N: M67-048)

Corning panels with 12 ports per panel in closet housing units (Corning P/N: CCH-CP12-59)

Factory certified pigtailed for all fiber terminations in closet housings (both Corning factory or CSC Corp in Buena Vista – and specify Corning Cable Systems components). 12 strand groupings (color coded) tight buffered riser, single mode, terminated directly on 900 micron buffer, SC/UPC, 3 meter, -55dB

Corning Cable Systems Altos cable, single mode, SMF28e, loose tube, gel-free, OSP

Fusion splice all pigtailed to OSP cable strands with heatshrink.

Outdoor splicing in substructure vaults should use Corning splice canister (capable of 144 strands of fiber optics) with one closed end and fusion splicing with heat shrink.

OTDR testing at 1310 & 1550 – meet all splicing standards (.2 fusion; .4 connector, etc.) and provide electronic and paper results.

## CITY OF SANTA MONICA MULTI-MODE FIBER OPTIC SPECIFICATIONS (FOR USE AT LESS THAN 500METERS ONLY – IF LONGER, USE SINGLE MODE)

Corning panels with 12 ports per panel in closet housing units (Corning P/N: CCH-CP12-57)

12 fiber Corning splice trays, Type 2S (Corning P/N: M67-048)

If fiber terminations occur inside a building, we require 19" rack mount Corning housings, preferably Pretium PCH-01U (24 ports or less – use 2 units if up to 48 ports) or PCH-04U (up to 144 ports). These include space for splicing in rear. Label front cover with remote fiber locations.

OTDR testing at 850 & 1310– meet all splicing standards (.2 fusion; .4 connector, etc.) and provide electronic and paper results.

Corning Cable Systems InfiniCor eSX+ fiber (50 micron). Jacket will be determined by environment – plenum for open-duct systems if cable is not inside metal conduit, pvc for all other indoor applications, and a composite jacket for all OSP applications.

Factory certified pigtailed for all fiber terminations in closet housings (both Corning factory or CSC Corp in Buena Vista – and specify Corning Cable Systems components). 12 strand groupings (color coded) tight buffered riser??, multi-mode, terminated directly on 50 micron buffer, SC/UPC, 3 meter, -55dB??

CITY OF SANTA MONICA STRUCTURED CABLING SYSTEM AND IDF BUILD OUT STANDARDS

- City's requirement for Structured Communications Cabling System (SCCS) is Belden/Nordx IBDN 4800 series. All Workstation Faceplates, Jacks, Patch Panel and Bix Wall Mount Termination frames are Cat 6 Belden/Nordx manufactured parts.
- The IDF will have to comply with IEEE ANSI/TIA/EIA-607 Minimum Requirements for Grounding and Bonding Standard Specification
- If there is a need for a 50 pair Voice Grade Bundled or Hybrid cable, the City will require that each individual cable type meet the TIA/EIA-568-B-2 specifications and that powersum NEXT loss created by adjacent jacketed cables be 3 dB better than the normally allowed pair-to-pair NEXT for the cable type being tested. Color Codes must follow individual cables standards to distinguish them from multipair UTP backbone cabling. Terminations for each end will be on a **Belden/Nordx IBDN PS5e HD-Bix 48 Port Patch Panel on one end and Bix Block termination on the opposite end.**
- A typical Workstation Faceplate is white and required to have at least 2 Data Cat 6 (Belden/Nordx 4800 series cables). Cable 1 will be terminated on a white Belden/Nordx Jack and Cable 2 will be terminated on a blue Belden/Nordx Jack. Please check example of color coding below for Workstations with more than 2 jacks installed. All Jacks must be rated Cat6 or better. Each termination will follow ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard.
- The City of Santa Monica's maximum length requirement is not to exceed 300 ft per cable run.
- All workstations will have to be tested and certified. The Cabling Vendor is required to submit to the City the test results per jack in both hardcopy and softcopy.
- Any Workstation that will require the installation of the cables on a kick plate for cubicle type offices will have to install the jacks on the kick plates with a Belden/Nordx Faceplate. This may vary based on the Cubicles Manufacturer. The cabling vendor should check for the proper IBDN Part number with Belden/Nordx.
- Jack inserts within the faceplate will be color-coded, as follows:

<u>Jack Identifier</u>	<u>Jack Color</u>	<u>Cable Position</u>
A	White	First cable of C1, C2 or C3 outlet
B	Blue	Second cable of C1, C2 outlet
C	Gray	Third cable of C1, C2 outlet
D	Black	Fourth cable of C2 outlet
E	Red	Fifth cable of C2 outlet
F	Green	Sixth cable of C2 outlet

- Blank Inserts are to match the faceplate color.

C1 - 4 position Faceplate  
C2 - 6 position Faceplate  
C3 -1 position Faceplate

Example for C1: (4 position Faceplate)

- 1st position - top left outlet - white color jack
- 2<sup>nd</sup> position - top right outlet - blue color jack
- 3<sup>rd</sup> position - bottom left outlet - gray color jack
- 4<sup>th</sup> position – bottom right outlet – black color jack

FACEPLATE LABELING ARE AS FOLLOWS:

- Floor # - MDF/IDF # - Faceplate # - Position Letter

Example of a 6-position faceplate at the 1st floor terminated IDF 2:

1-2-1-A  
1-2-1-B  
1-2-1-C  
1-2-1-D  
1-2-1-E  
1-2-1-F

- The cabling Vendor will provide the installation of 10 -foot Cat 6 Blue Belden/Nordx patch cords, and 4-foot Cat 6 Belden/Nordx patch cords to be used for either side of each data cable installed. The number of patch cords will be equivalent to the number of Jacks installed on both locations (Workstation and patch panel).

DATA PATCH PANELS:

- Provide 48 Port Belden/Nordx Gigaflex PS6 2U Patch Panels with RJ45, conforming to the following specifications:
  1. Suitable for mounting in standard EIA 19" racks
  2. Configured with 48 jacks housed in each 2U (3") of usable rack space.
  3. Provide strain relief for each cable terminated on the connector at the rear of the patch panel.
  4. Allow for labeling of each individual connector
  5. Allow any individual cable to be terminated or otherwise handled without disturbing other cables.

COAXIAL CABLING FOR CATV.

1. Plenum Rated quad shield coaxial cable. Provide RG-6/U 75 Ohm, quad shield, plenum rated (CMP) coaxial cable. Commscope 2229V or equal.
2. Coaxial Connectors: Corning Gilbert Utraseal series "F" Connectors or equal.

LINK CABLE – OPTICAL FIBER CABLE:

- Multimode Cable Elements shall conform to the following specification:
  1. Corning Infinicor SX+ 50 micron Optical Fibers
  2. 50/125 micron multimode optical fiber cable with glass core and cladding (tolerances 50+/-3 micron, 125 +/-2 micron)
  3. Graded refractive index profile
  4. Attenuation coefficient at 850 nm of 3.5 dB/km or less
  5. Attenuation coefficient at 1300 nm of 1.5 dB/km or less
  6. Bandwidth distance product at 850 nm of 2000 MHz.km or more
  7. Bandwidth distance product at 1300 nm of 500 MHz.km or more
  8. Individual glass elements proof tested at 100 kpsi (100,000 lbs per square inch)

QUALIFICATION REQUIREMENTS:

- All Bids will be on a prevailing wage rate. The City may require the installer to submit a copy of a certified payroll during the course of the installation.
- The Communications Cabling Installation shall be carried out by a Belden/Nordx/CDT's Certified Systems vendor.
- The installer shall have a proven track record in the field of Voice, Data and Video Structured Cabling System (a copy of the certification will be required).
- A list of references and previous installation of comparable size shall be submitted within the last three years.
- Include in the submittal the description and part numbers of each component of the Voice, Data and Video Cabling Systems.